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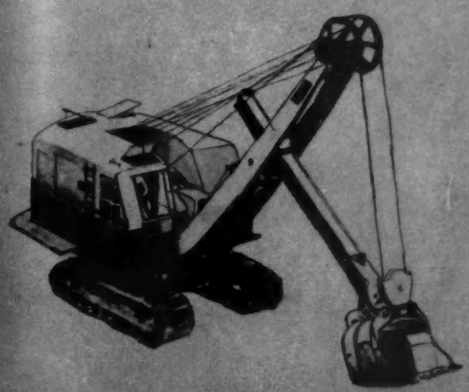

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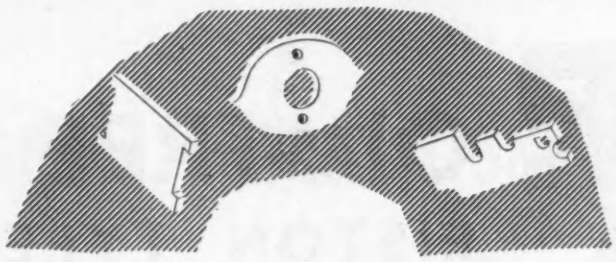

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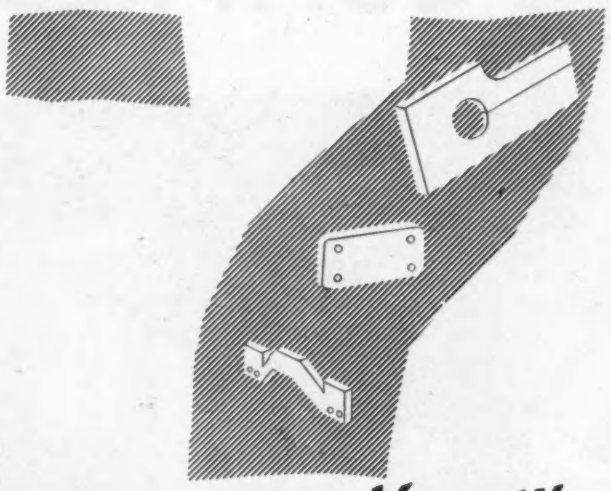

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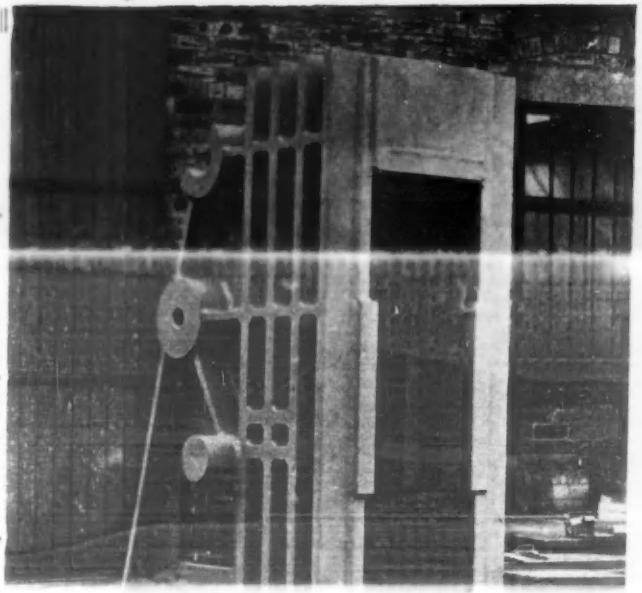

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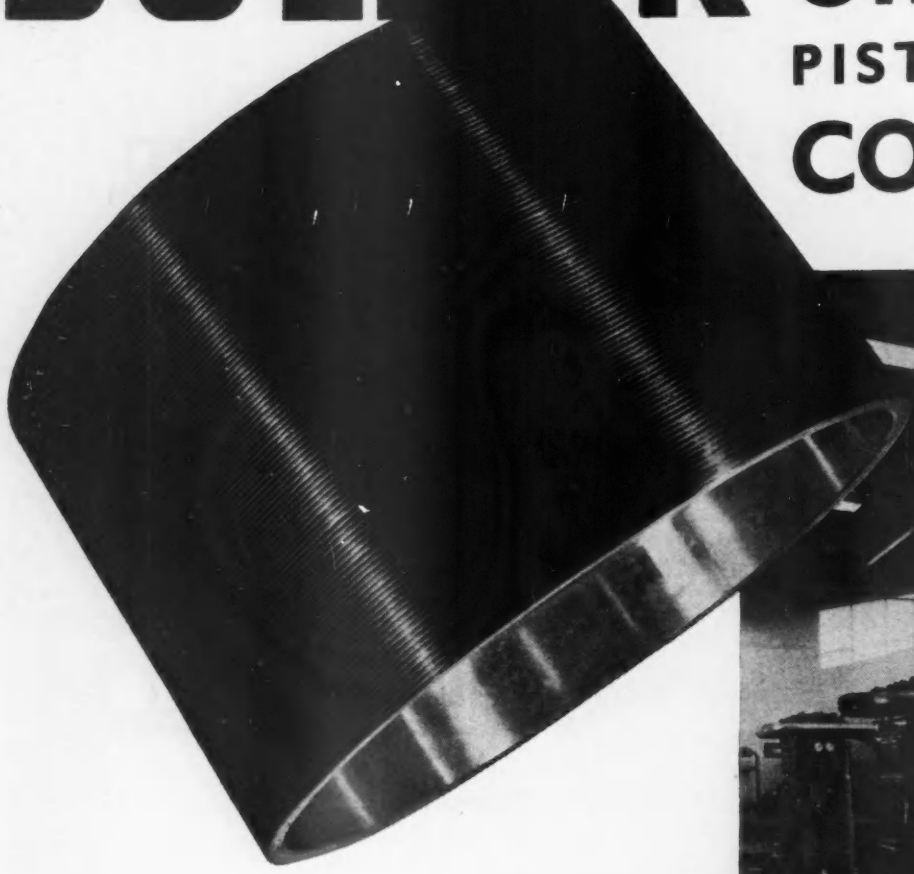

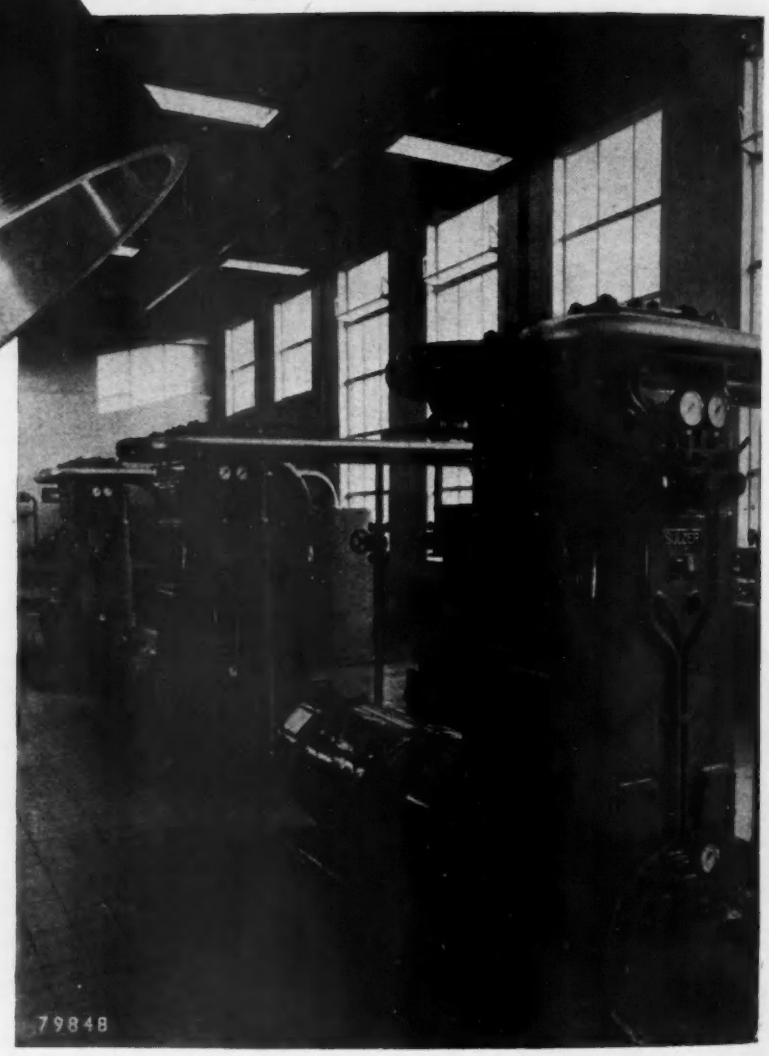

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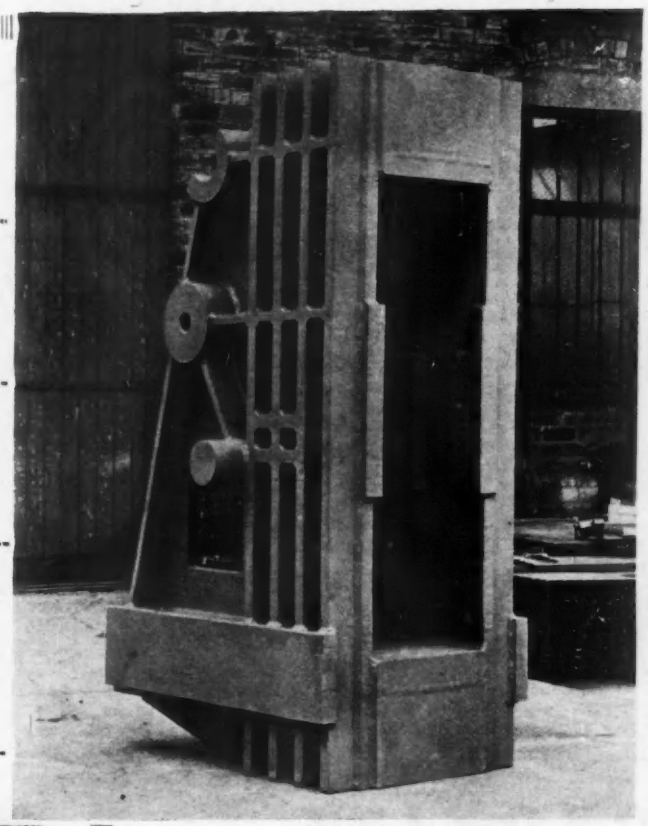

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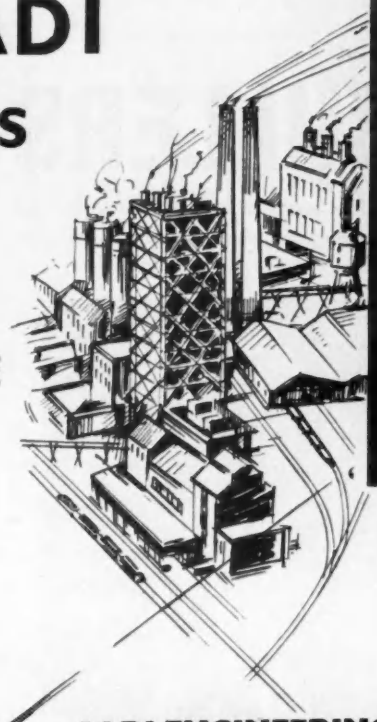

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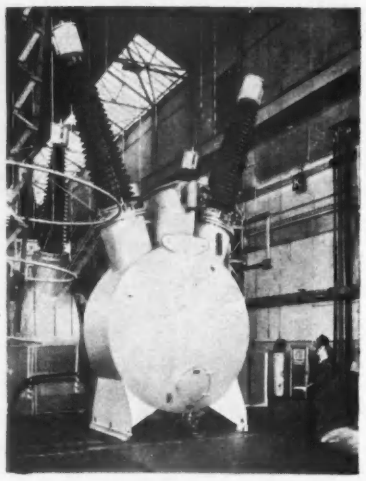

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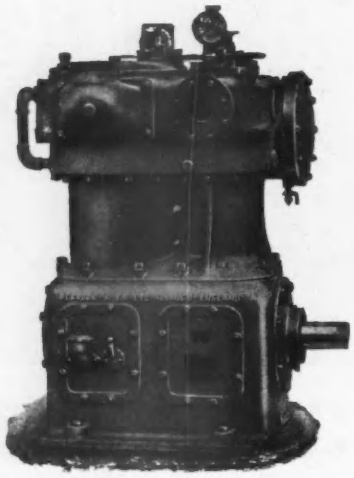

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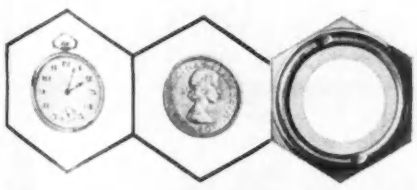

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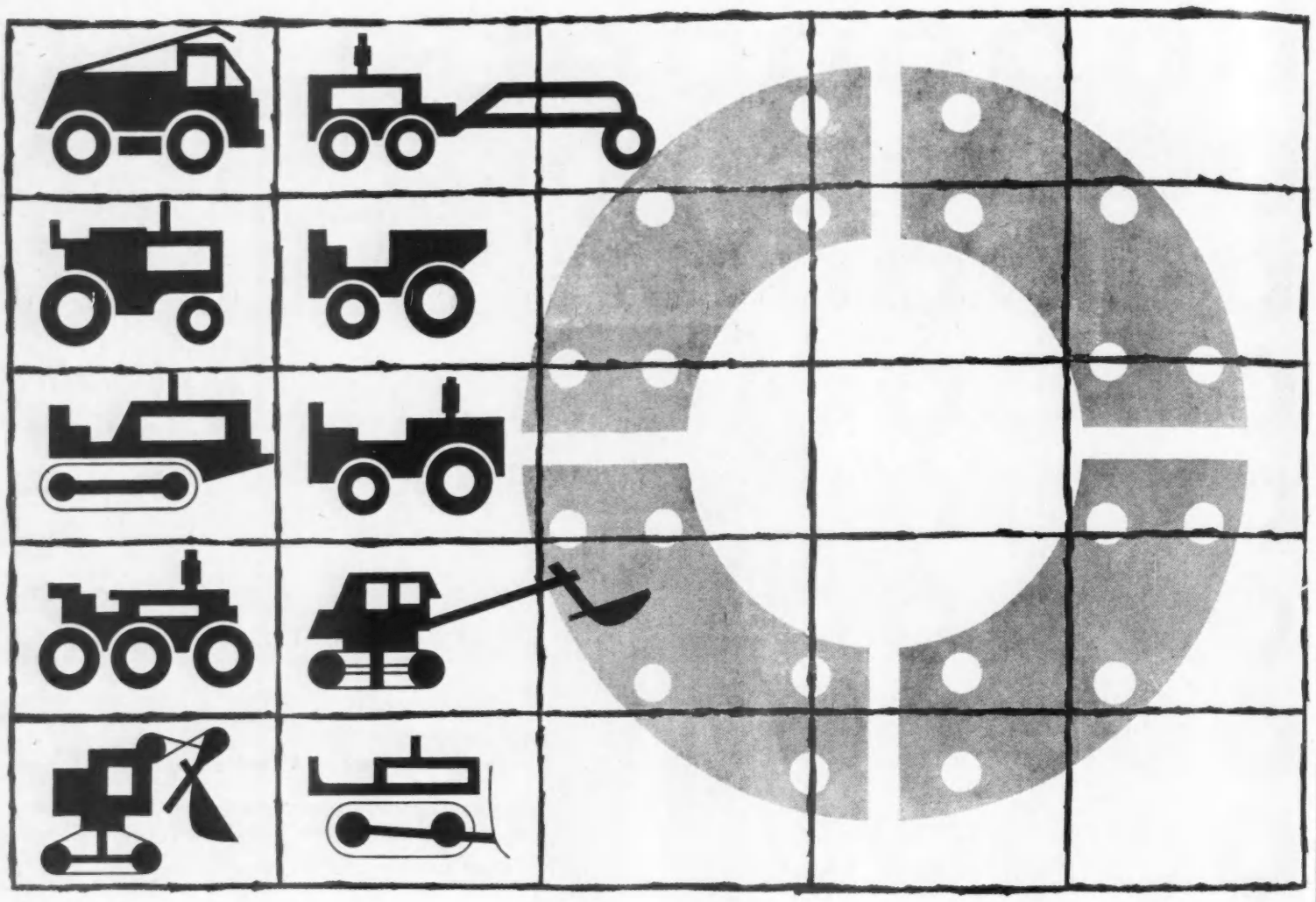

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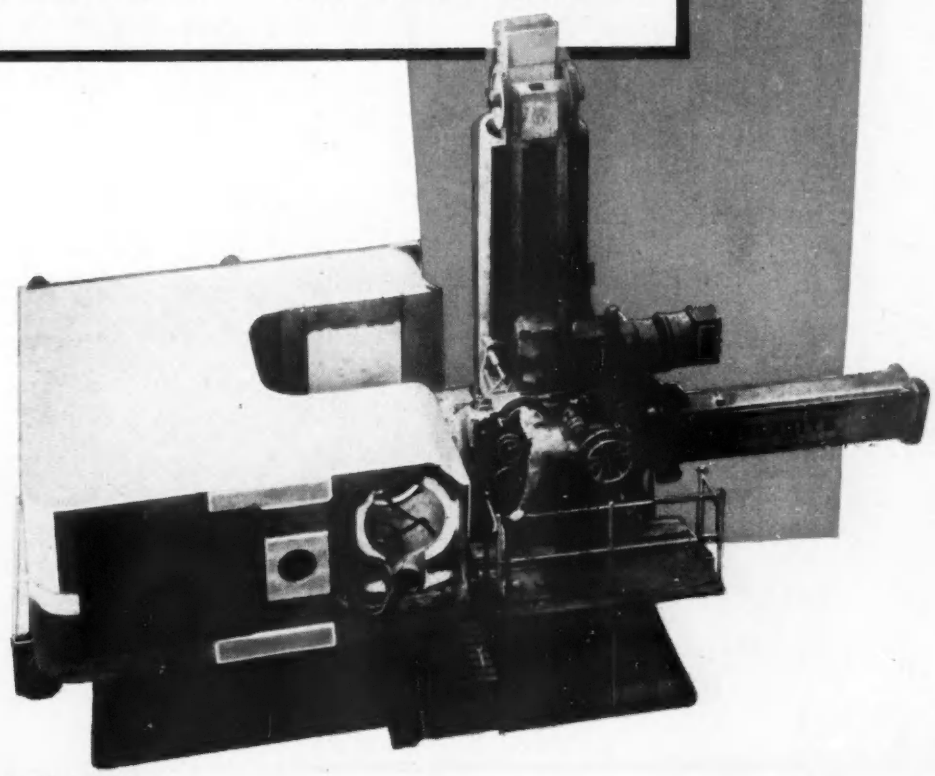

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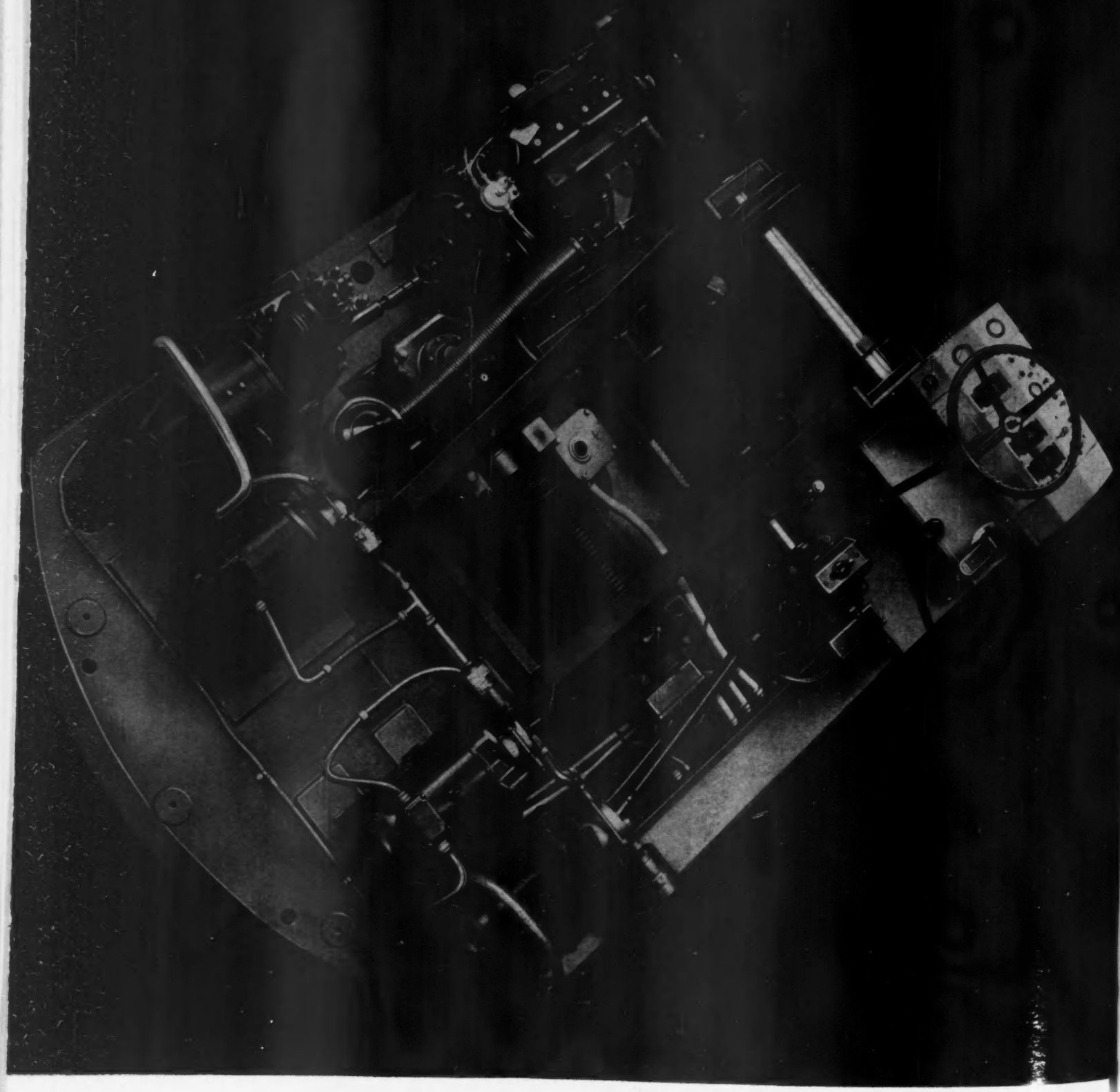

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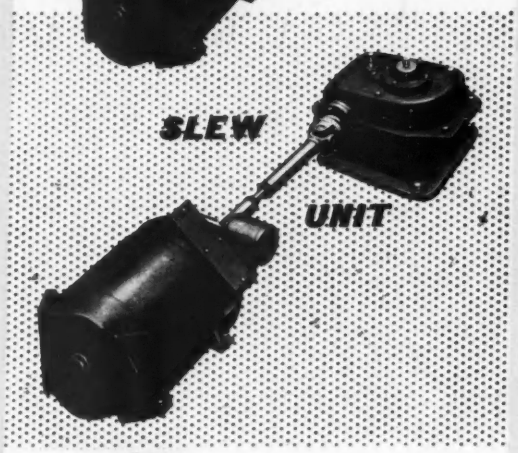

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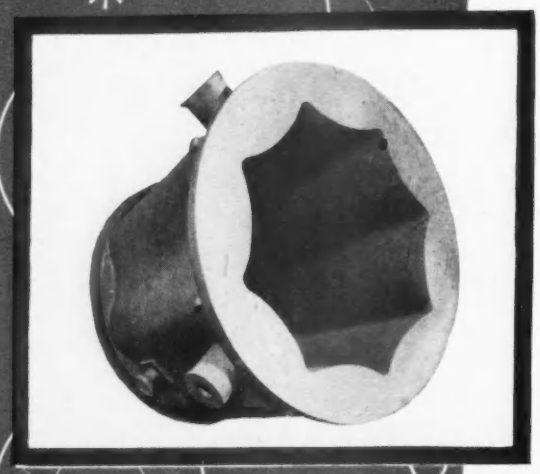

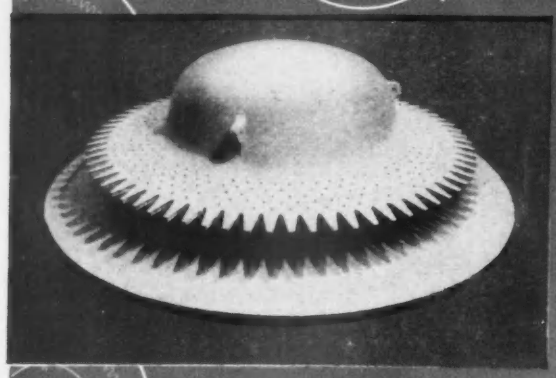

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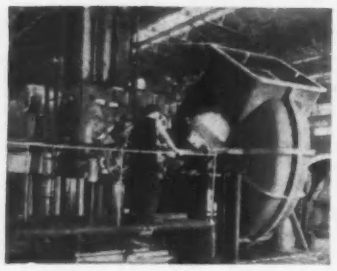

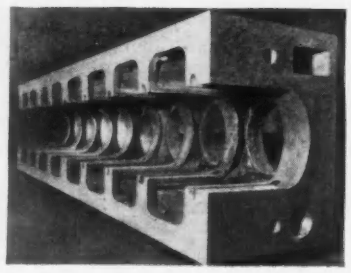

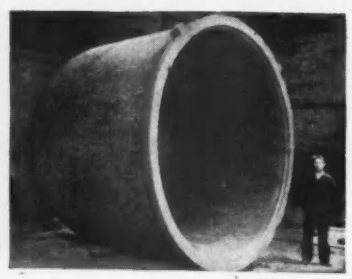

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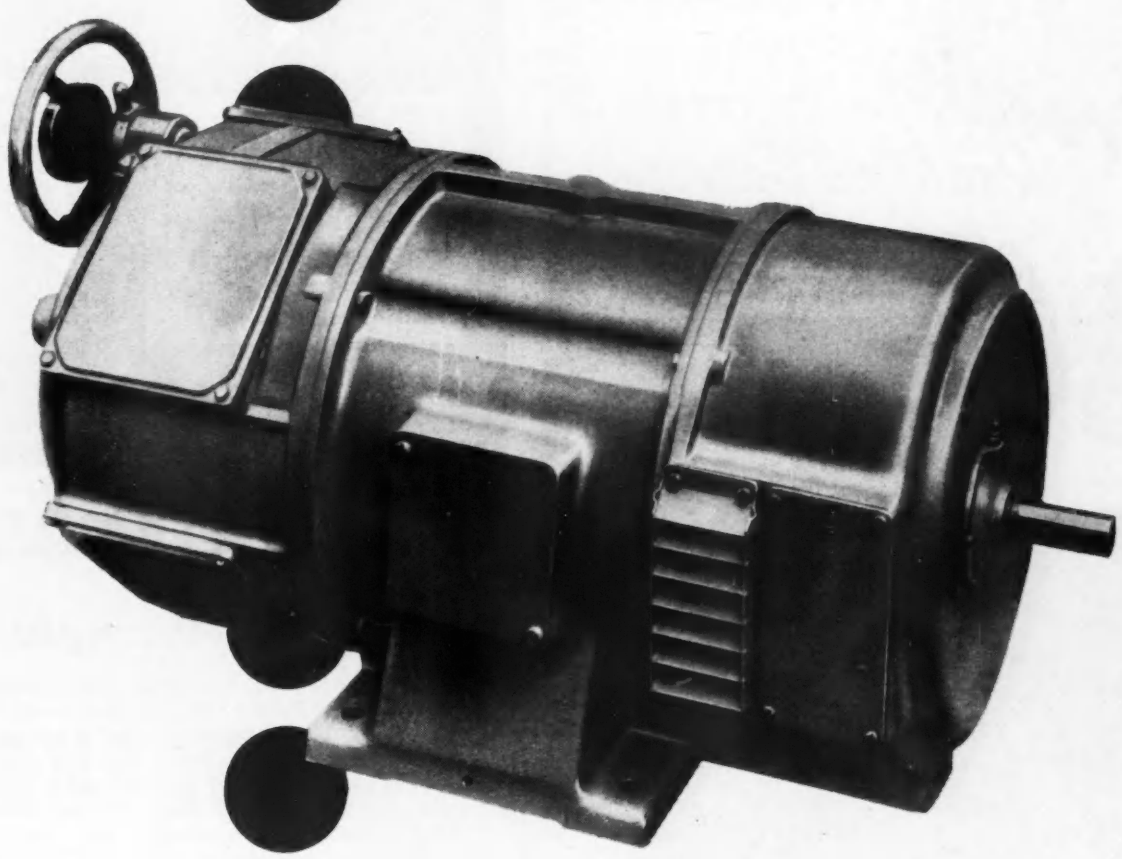

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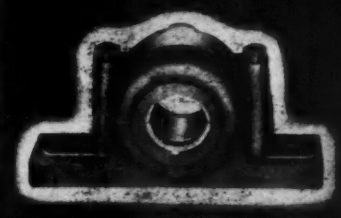

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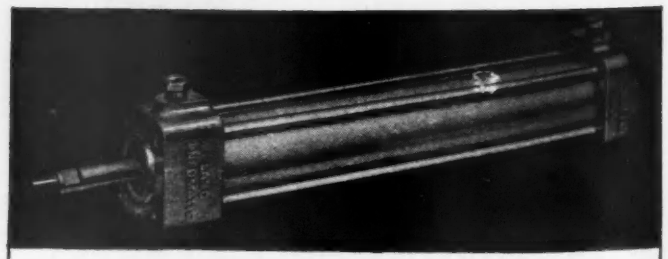

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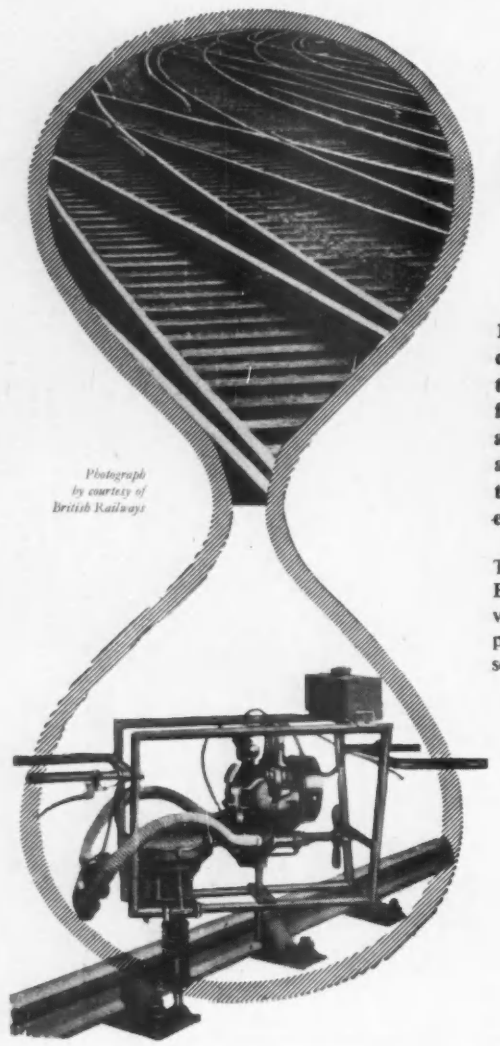

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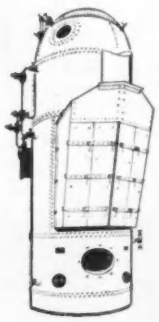

. . . are cause for anxiety and losses in many production processes. They are avoidable and where they exist consideration should be given to the means of overcoming them.

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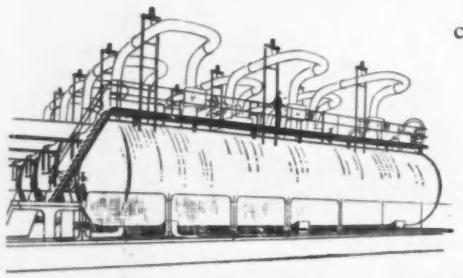

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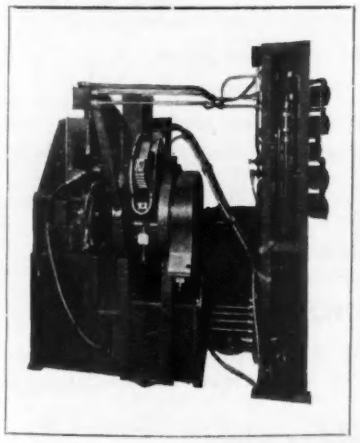

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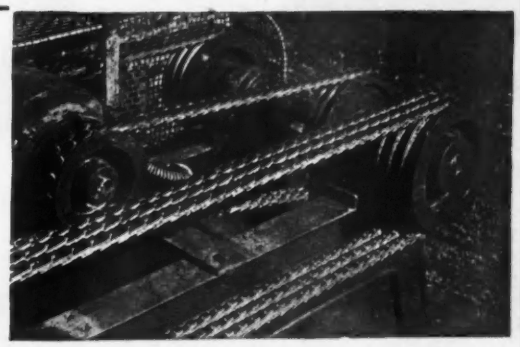

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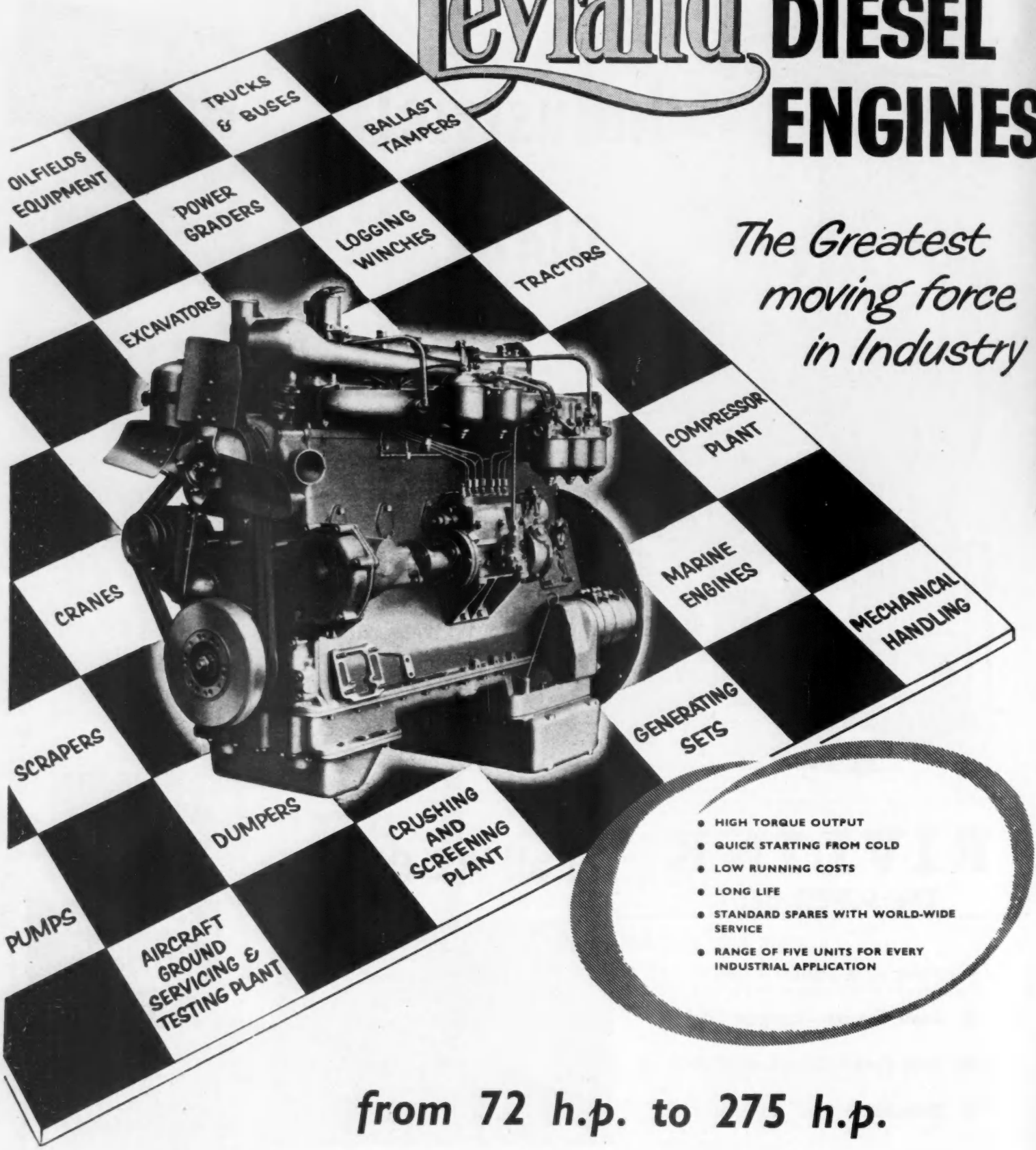

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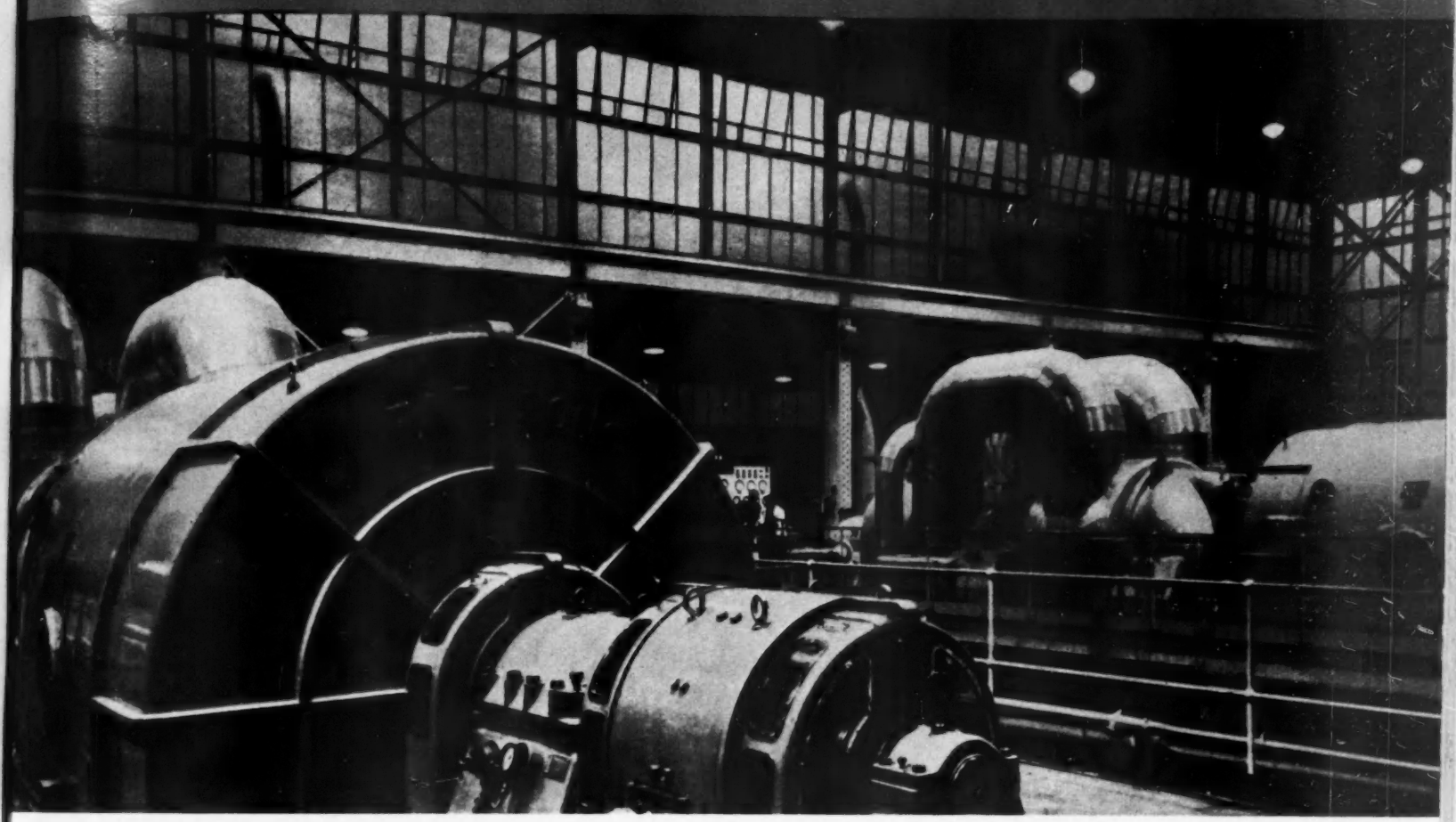
PARSONS are at Chapelcross

and other nuclear power stations



Two of eight PARSONS 23 MW turbo-generators at Chapelcross Nuclear Power Station

Calder Hall 'A'

PARSONS constructed and installed: Four 23 MW turbo-generators (including condensers and auxiliaries). Eight gas circulators. Two dump condensers, together with all the associated duct-work for two reactors.

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THE PARSONS COMPANY came into the nuclear field in 1946 with the manufacture and erection of the 800 ton cyclotron at The Atomic Energy Research Establishment, Harwell.
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The outcome of the Authority's efforts were Calder Hall "A" and "B" and Chapelcross nuclear power stations, for which PARSONS supplied the turbo-generators and associated equipment and gas circulating plant.

* *PARSONS are "a member company" of The Nuclear Power Plant Co. Ltd., who received the order from CEGB to construct the 300 MW nuclear power station at Bradwell. NPPC are also constructing in conjunction with AGIP Nucleare, the Latina Nuclear Power Station, Italy.*

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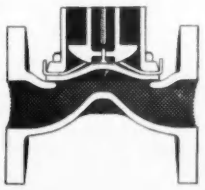
Apart from their use as valve diaphragms Silastomer silicone rubbers have many applications as seals and gaskets which must remain durably resilient at elevated temperatures. Grades are available to resist petrol, lubricating and hydraulic oils. Silastomer is also used in paste form as a high temperature caulking and sealing compound and can be coated on to glasscloth for use as heat resistant sleeving, ducting and diaphragms.

The photograph shows one of the many types of Saunders Valves in use in industry.

BY COURTESY OF SAUNDERS VALVE CO. LTD.

The sectional view shows the resilient diaphragm in the Saunders Valve. The excellent temperature stability of silicone rubber diaphragms enables these valves to be used for conveying gases and chemicals at extremes of temperature.



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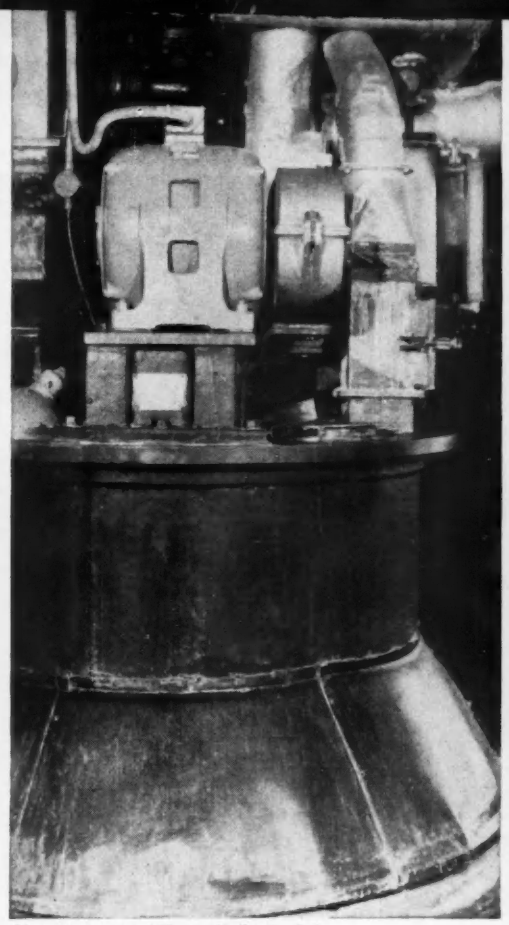

Photo by courtesy of Thomas Hedley Co. Ltd.

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Silicone motor rewind saves £400

Thomas Hedley & Co. Ltd., at the company's West Thurrock factory, found that one of their motors working in a particularly wet position, on a mixing tank used in the manufacture of synthetic detergents, broke down at average intervals of 6 months. Rewinds were tried in Class A insulation (costing £30 each time), and in Class B insulation with extra varnish dips to give additional protection against moisture – both without success. Finally they tried a silicone rewind. This was nearly seven years ago and the motor has been operating since without failure, thus saving approximately £400 in rewind costs. In addition losses in production time due to motor failure have been eliminated.

MS silicones strengthen the weak link in all forms of electrical equipment – its insulation. With silicone-insulated motors the risk of breakdown through insulation failure is very greatly reduced. Have your most troublesome motors rewound with silicone insulation. Write to Midland Silicones for names of rewinders with experience in using silicone insulation.

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Kill foam and increase the productive capacity of machine tools with a highly efficient MS silicone defoamer. The water and oil coolants used in the heavy-duty grinders shown in the photograph foamed so badly that it was necessary to shut the machine down for 15 minutes of every hour just to clear foam away. Conventional foam inhibitors were partially effective, but reduced the efficiency of the coolant.

A silicone antifoam agent was added to the coolant and foam vanished immediately – "like a punctured balloon" – and hourly grinder output increased 25%.

MS silicone defoamers are effective in low concentrations making them most economical in use. They will remain stable for long periods in either hot or cold storage conditions.

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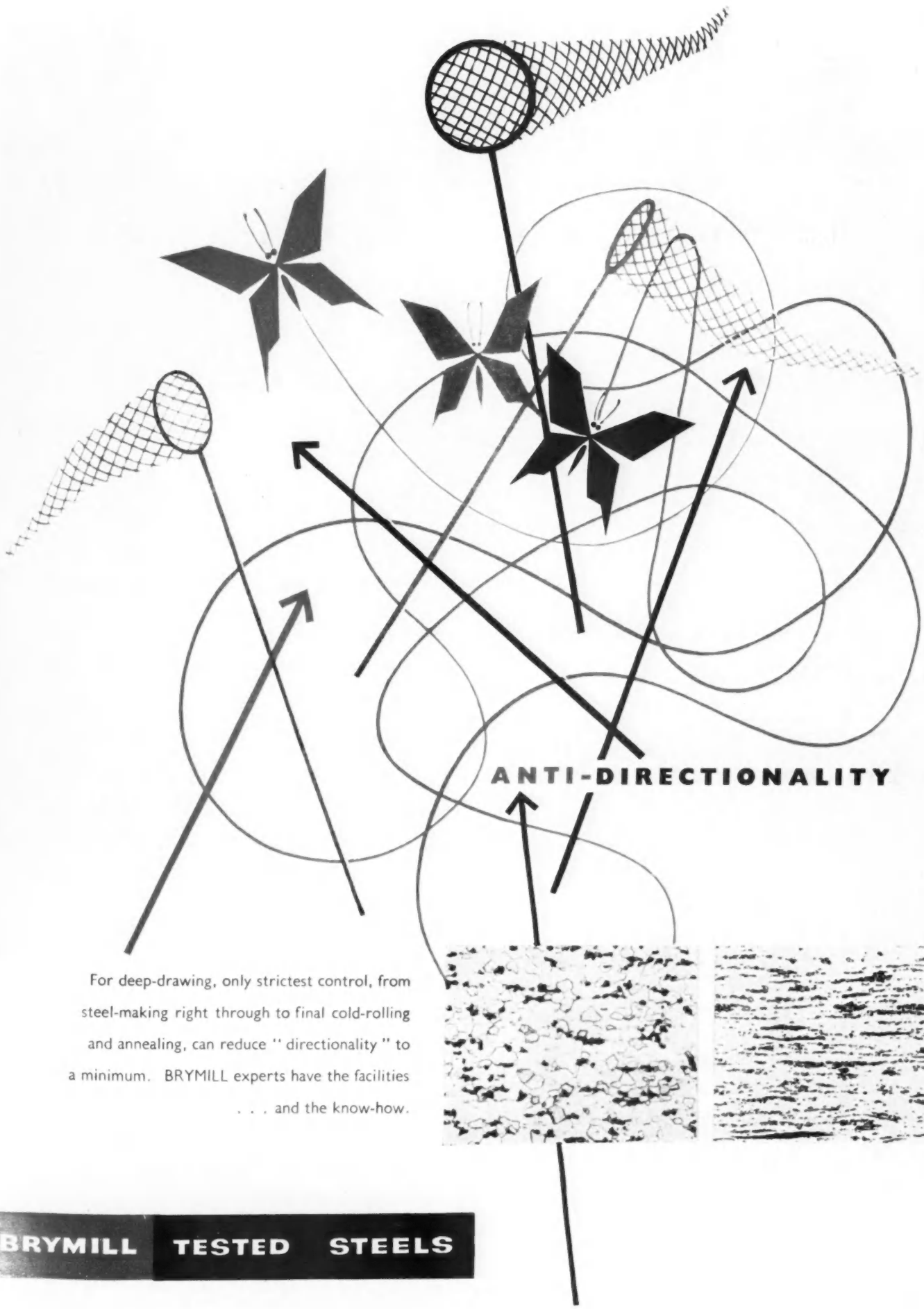

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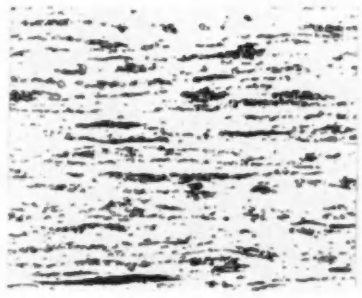

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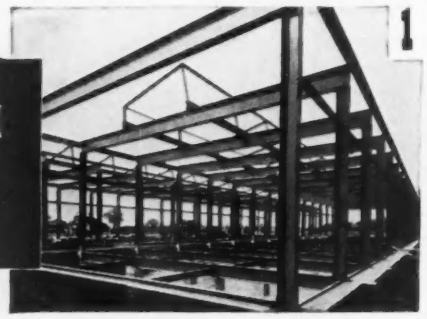

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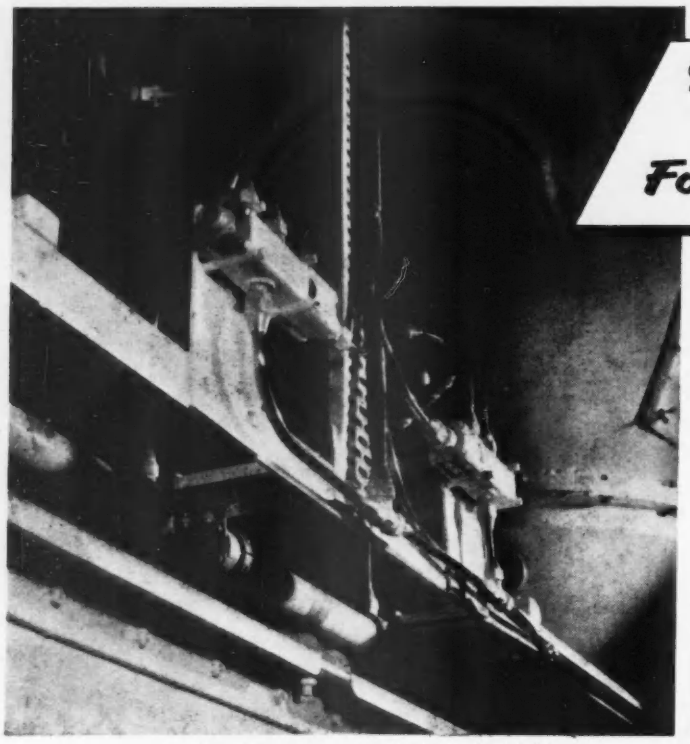

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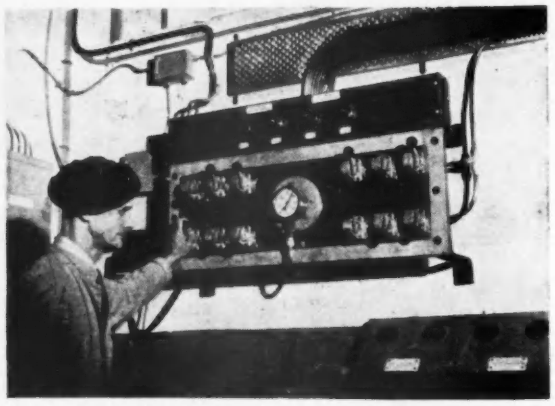
SMOOTH DEPENDABLE PNEUMATIC CONTROL REGULATES PROCESSING IN *Food Mixing Hoppers at Spillers*

An industrial application recently installed and giving satisfactory results is the opening and closing of slides on mixing hoppers at Messrs. Spillers Animal Food Mixing Plant, Birkenhead.

A total of twelve slides, one inlet and one outlet slide for each of six hoppers, is controlled by Westinghouse equipment.

The main advantages of Westinghouse controls in this particular installation is the location of the operating valves on a control panel away from the mixer floor, with the resultant saving of manual operation and man-power.



The remote control panel is situated away from the mixer floor.

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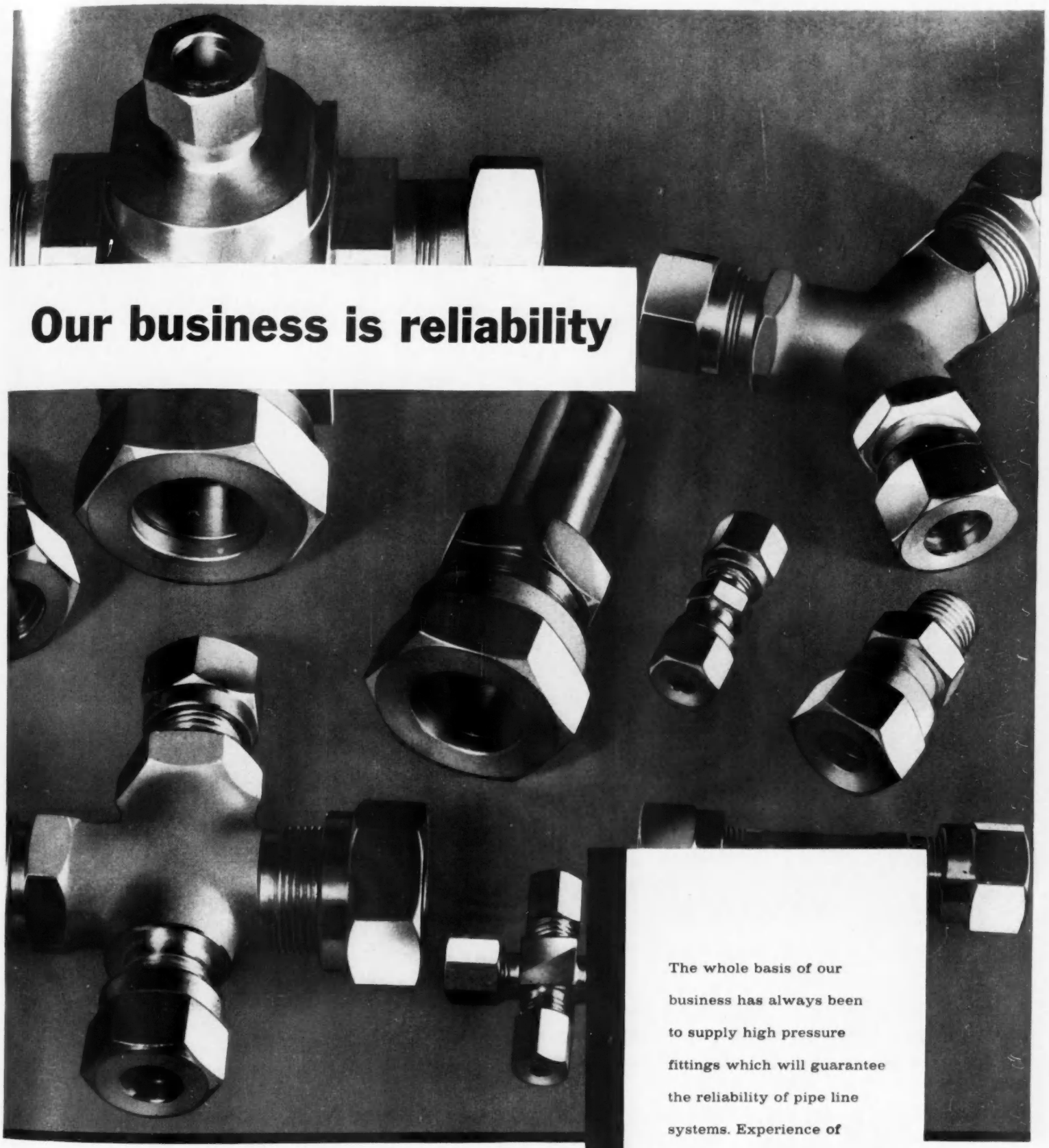

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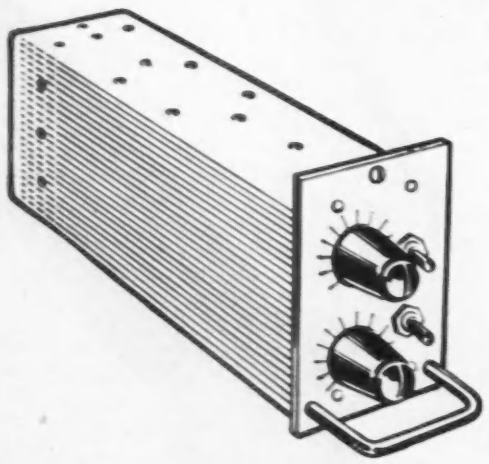
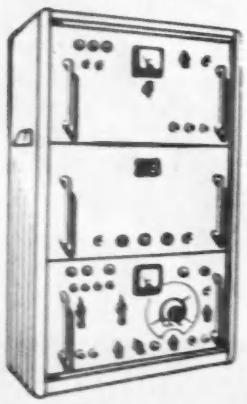
TRANSISTOR GALVANOMETER AMPLIFIER



This Amplifier has been designed to drive viscous damped recording galvanometers which normally have a resistance of 50 ohms and a working range of D.C. to 2 Kc/s in frequency. The amplifier has a switched attenuator at its input and will accept single ended or push pull signals from ± 1 Millivolt to ± 500 volts and will feed a maximum of ± 50 Milliamps to the galvanometer. There is also a range of ancillary units available for use with this Amplifier as part of a comprehensive instrumentation system. *Standard specification: Dimensions: 4¼ in. x 3¾ in. x 10 in.; Frequency response: Flat from DC to 2 Kc/s, 5% down at 3 Kc/s, 3db down at 6 Kc/s; Noise level: less than 10 Microvolts; Input impedance: 40,000 ohms on range 5, 110,000 ohms all other ranges; Gain: Maximum 7·5 Milliamps/Millivolt, minimum 0·04 Milliamps/Volt; Power requirements: ± 6 Volts D.C. 220 Milliamps each line.*

COMEL 8 & 12 SWEEP OSCILLATOR AND VIBRATION CONTROLLER



This unit is designed to drive vibrator amplifiers and has a wide frequency range. The sweep speed is variable over a range 12:1 and automatic frequency sweep facilities are provided. *Frequency Range: 10 c.p.s. to 32 Kc/s in ranges of 5 octaves each. There are 7 switch speeds ranging from 5 secs./octave-60 secs./octave. Variety of Outputs available. Vibration Controller: Input: 4V r.m.s. at appropriate frequency. Output: Up to 100 mV r.m.s. into 600 ohms. Pick Off: Sensitivity 10 mV r.m.s. per "g" peak. Overall Dimensions: 35" x 22" x 14". The Vibration Controller will control ± 40 "g" or as determined at low frequencies by the excursion of the vibrator table.*

All devices are adaptable to suit customers' own requirements. For further information consult:

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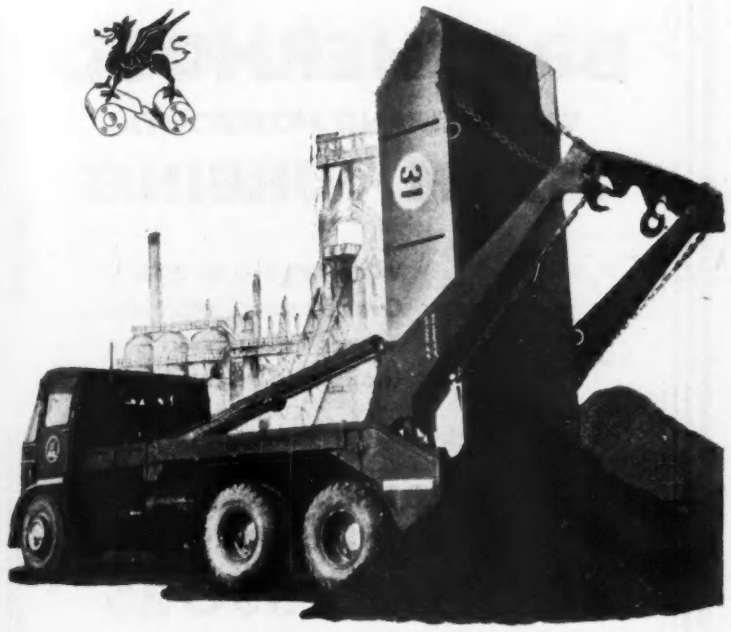

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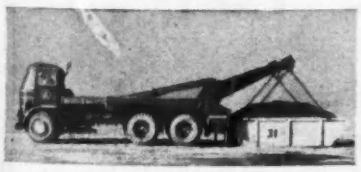
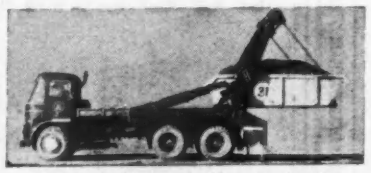
HYDRAULICALLY CONTROLLED SOLELY BY THE DRIVER from his cab the unit loads and unloads itself with detachable containers, one of which is transported whilst the other is being loaded. This, of course, effects astonishing savings in waiting time and labour costs.



Rear independent hydraulic stabilizer jacks down. Load to be raised to Unit Deck.



Showing load being raised by retraction of hydraulically operated lifting arm rams.

Hydraulically operated rams fully retracted Load located on Unit Deck, lacks retracted.

Positive action hydraulically controlled rams provide easy dumping.

We shall be happy to send you our fully descriptive brochure, or to examine your handling problems and make our recommendations.

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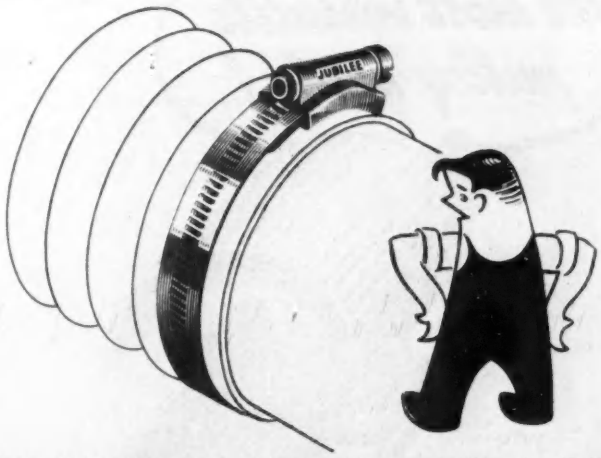

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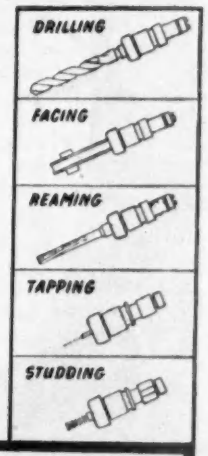

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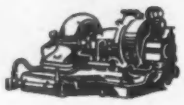

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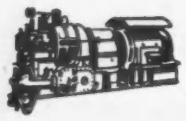

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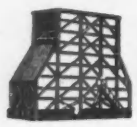

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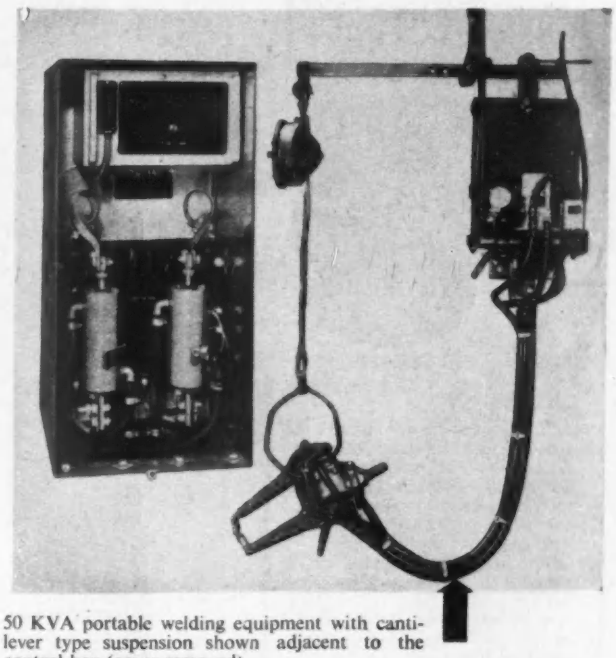

50 KVA portable welding equipment with cantilever type suspension shown adjacent to the control box (cover removed).
The arrow indicates the patented "UNIFLEX" secondary lead also manufactured by British Federal.

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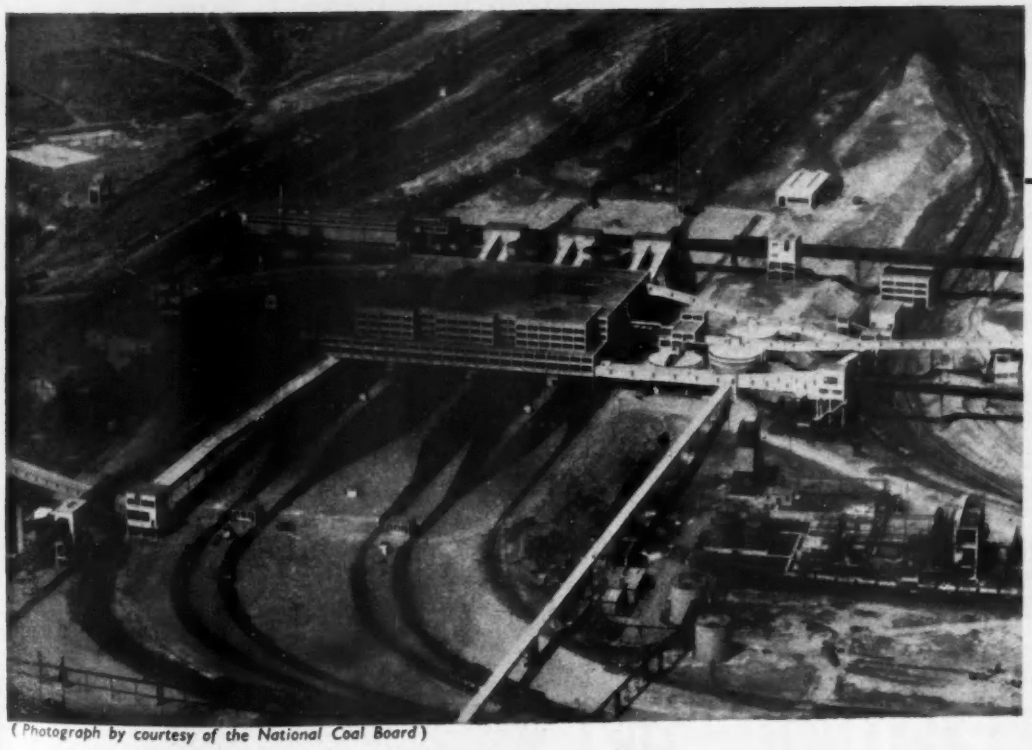

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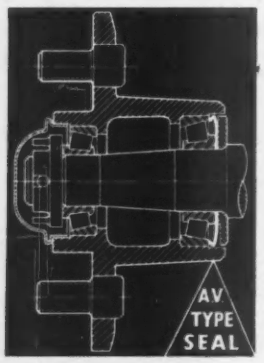

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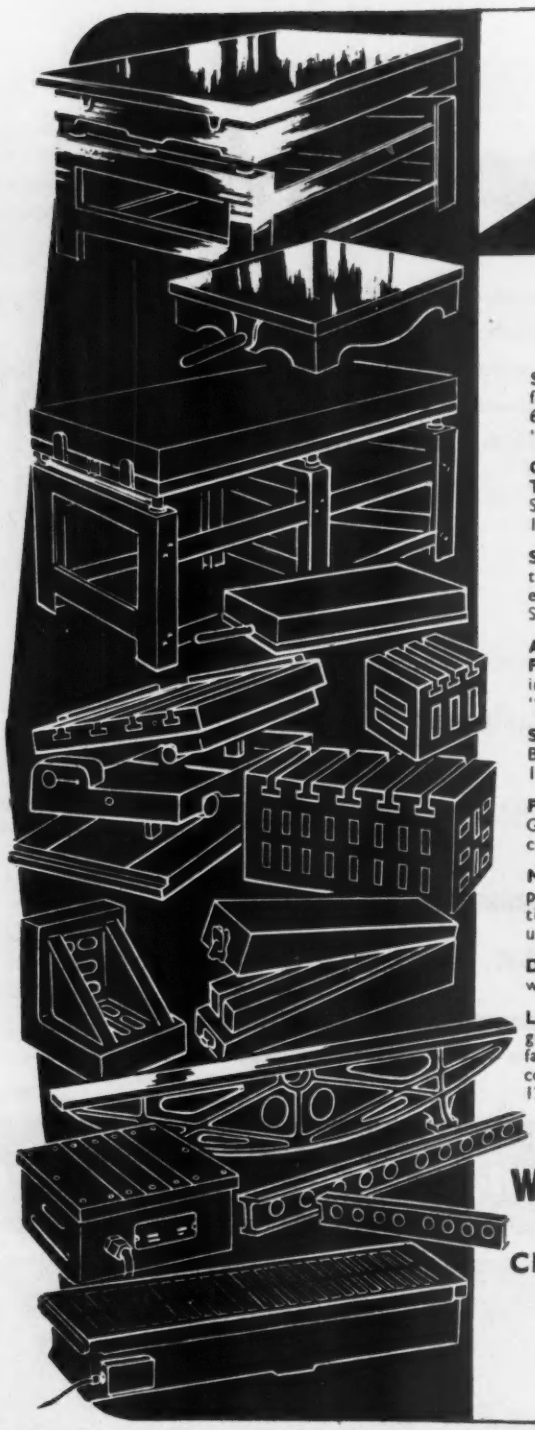

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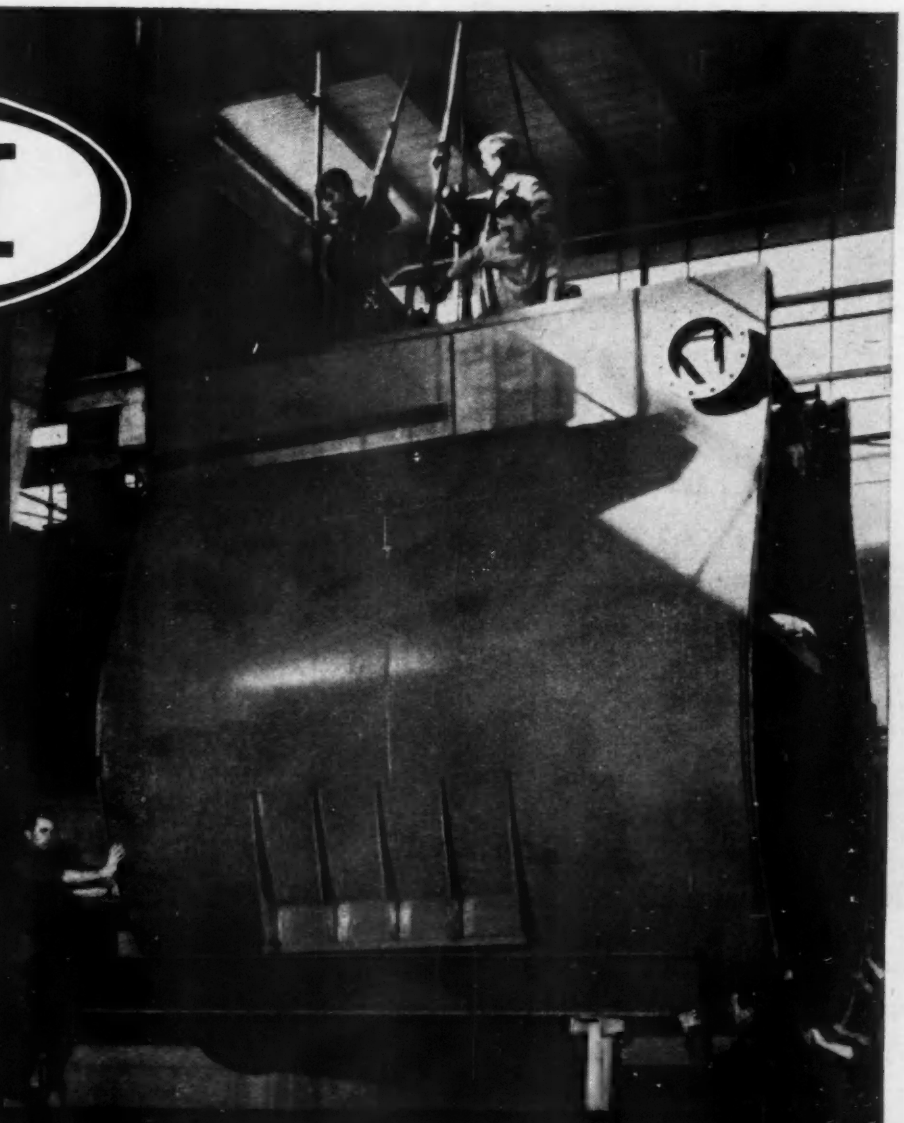
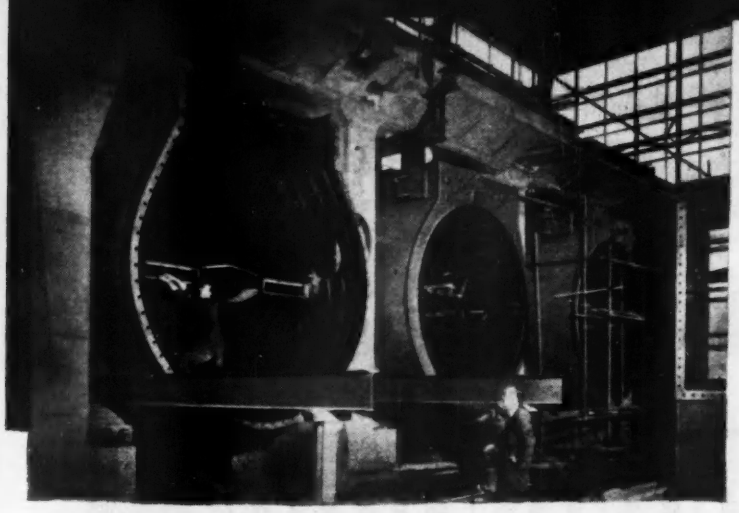


One unit of a three-shell surface condenser being placed in position at Berkeley, the commercial nuclear power station now under construction in Gloucestershire by the A.E.I.—John Thompson Nuclear Energy Company.

FOR BERKELEY NUCLEAR POWER STATION



A general view of three condenser shells in position at Berkeley.

The entire turbine-house heat exchange equipment for the new power station at Berkeley is being supplied by the A.E.I. Turbine-Generator Division, and manufactured at their factory at Germiston Glasgow.

Four three-shell main condensers — one for each of the four 83 MW mixed-pressure steam turbine-generators also being supplied by A.E.I.

Two-stage feedwater heating equipment for each turbine-generator.

Two 'dumped' steam condensers to handle surplus steam generated when commissioning the reactors, or in the event of a sudden shut down.

Other equipment in manufacture includes the steam jet air ejectors, water/water heat exchangers for the generator cooling circuit and general gas circulator service, oil coolers and generator hydrogen cooler units.

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incorporating the interests of M-V and B.T-H. Manchester and Rugby.

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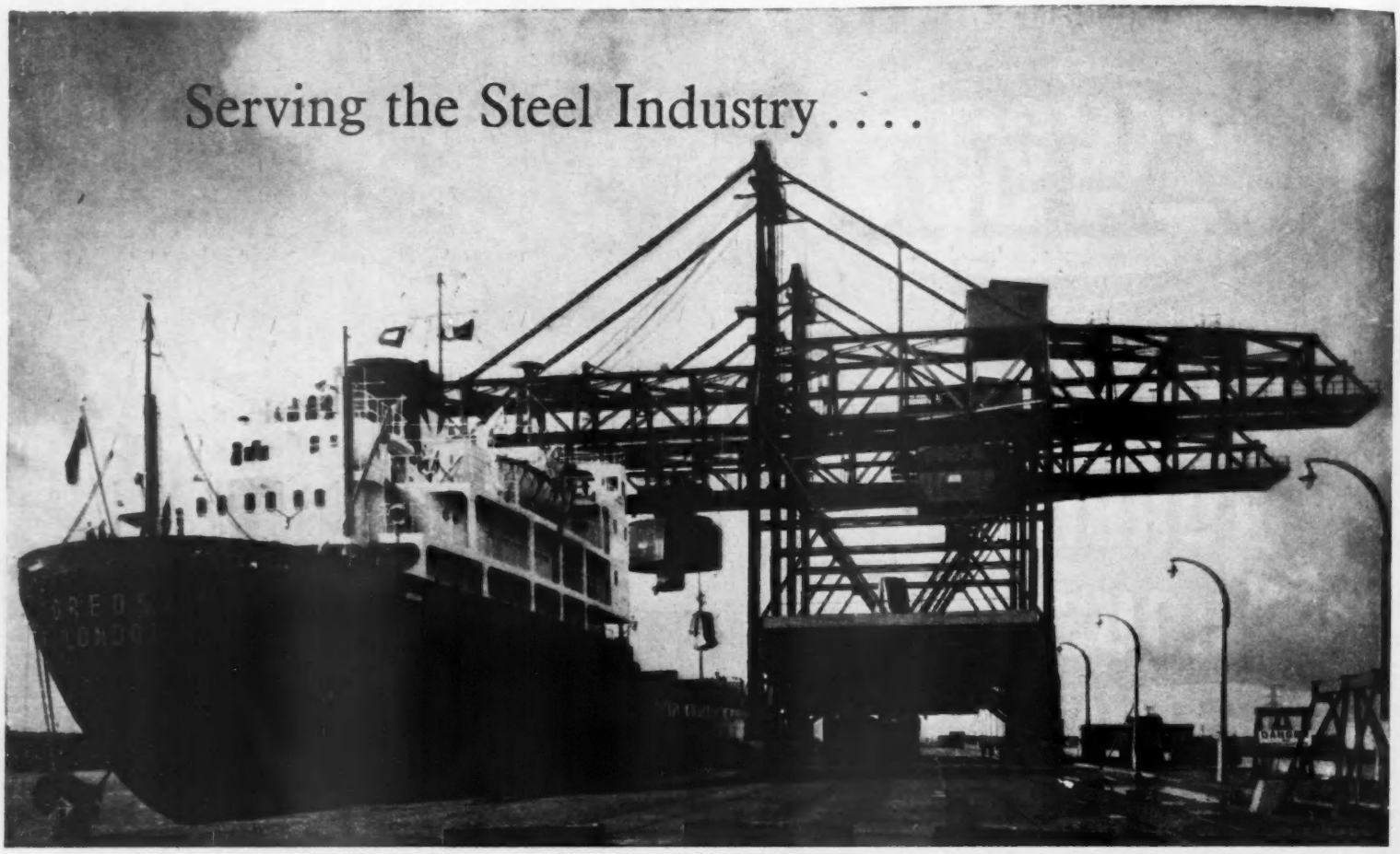

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Inset picture shows a range of tools all of which can be refaced with "Stellite" when worn. Tools used for clipping buffer heads between 13" and 18" diameter

Illustrations by permission of George Turton Platts & Co. Ltd., Meadow Hall Road, Wincobank, Sheffield

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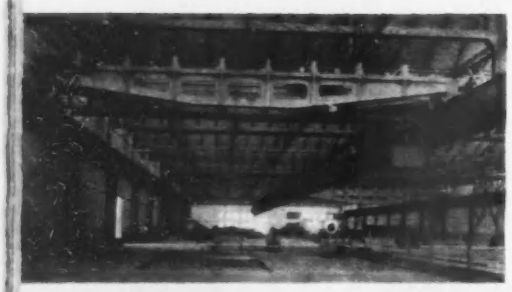

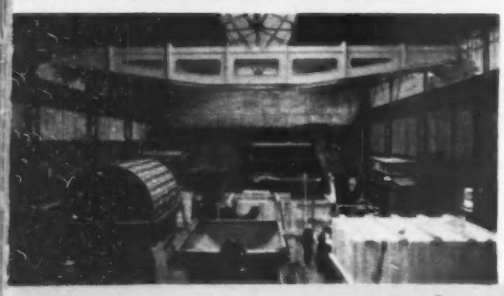

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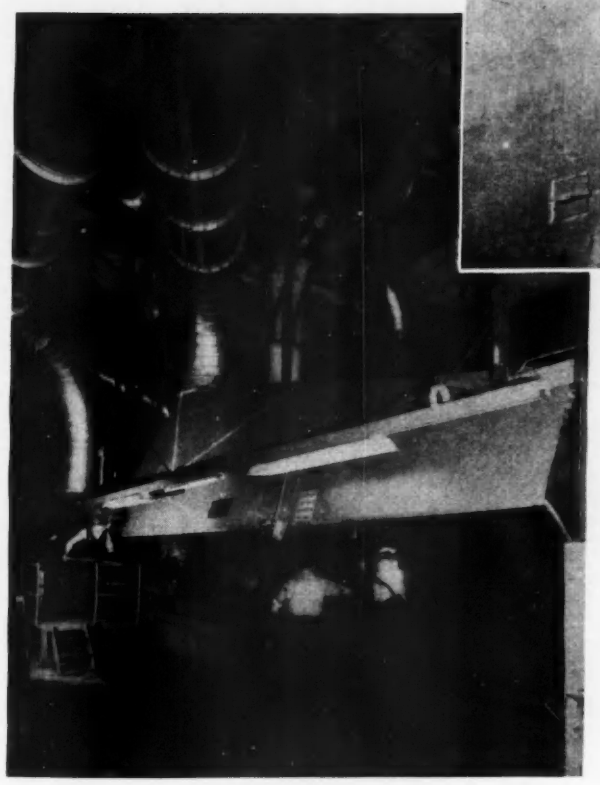

Exhaust hoods at the clamps-off and castings removal stations. Photographs reproduced by permission of the Ford Motor Co. Ltd.

The Holmes-Schneible System installed at the new Thames Foundry of the Ford Motor Co. Ltd., removes more than half a million cubic feet of dust and fume laden air per minute, thus ensuring optimum working conditions twenty-four hours per day. In addition over 200,000 cubic feet of clean air per minute are supplied at certain points as 'compensating air' to maintain the foundry heating balance.

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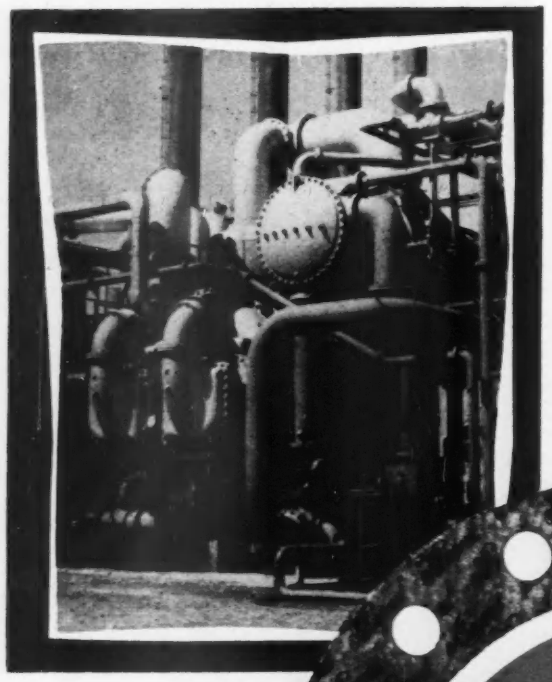
For full details please write for a copy of Publication No. 54/3



Klingerit

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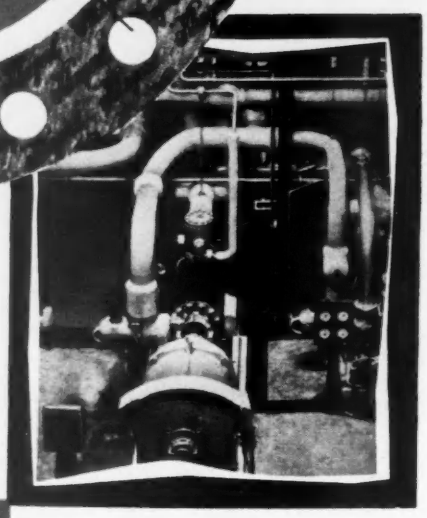
For ROUND the CLOCK RELIABILITY



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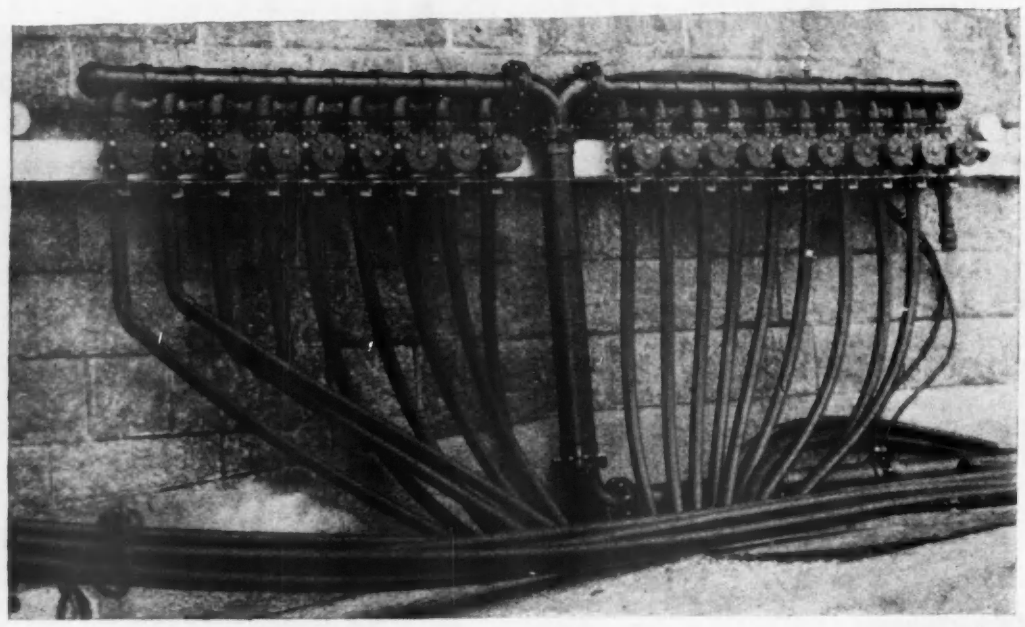
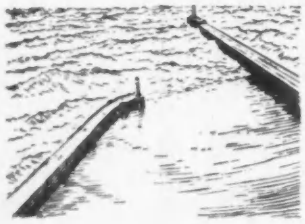


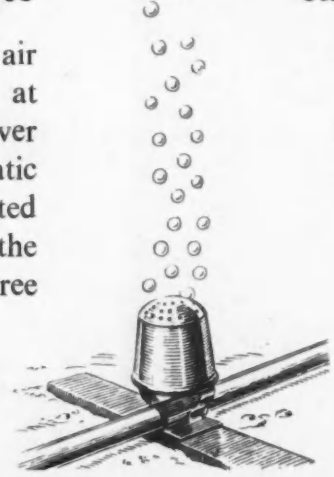
Saunders Valves with Vulcathene bodies, Marleythene Pipes and Vulcathene Manifold in the Pneumatic Breakwater

Safety at Sea . . by Air

Bubble barrage to calm harbour water

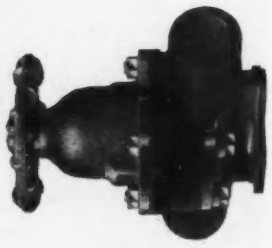


By their system of air bubble distribution at the entrance to Dover Harbour, Pneumatic Breakwaters Limited cleverly redirect the wave forces to a degree that enables berthing to be safely undertaken with rough weather prevailing.



Giant air bubbles, vented from two pipelines on the sea bed in this experiment, are controlled by Saunders Diaphragm Valves arranged in the Vulcathene manifold illustrated above.

Such bubble blowing below demands leak-proof control at the valves.



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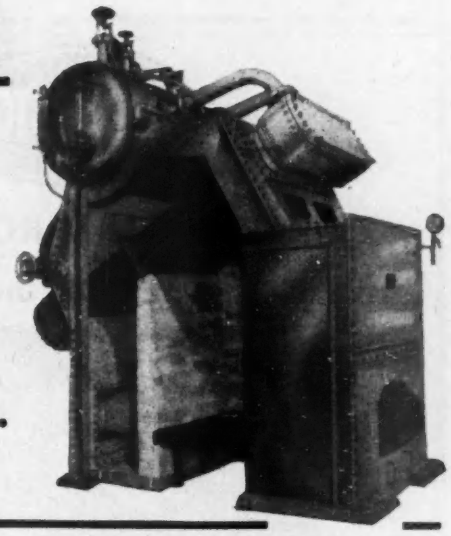

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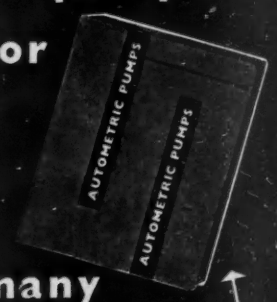

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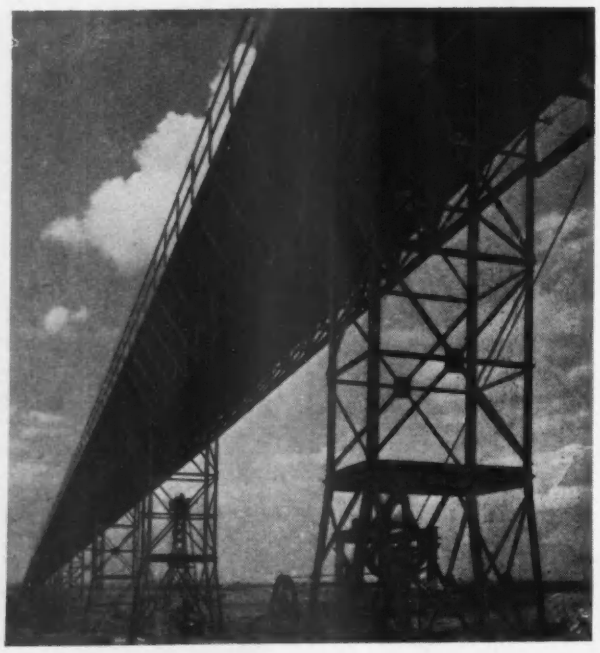

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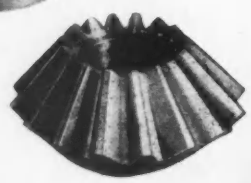

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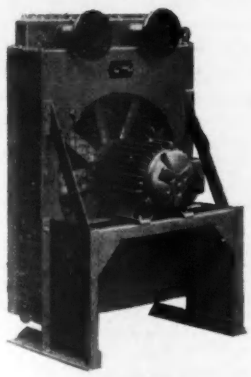

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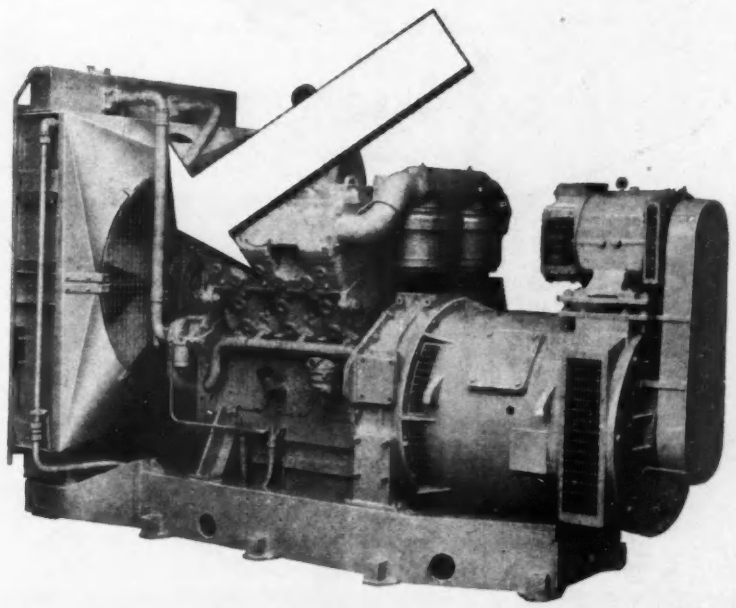

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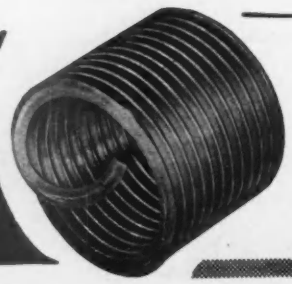

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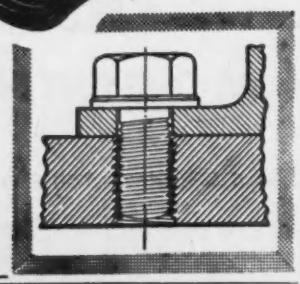

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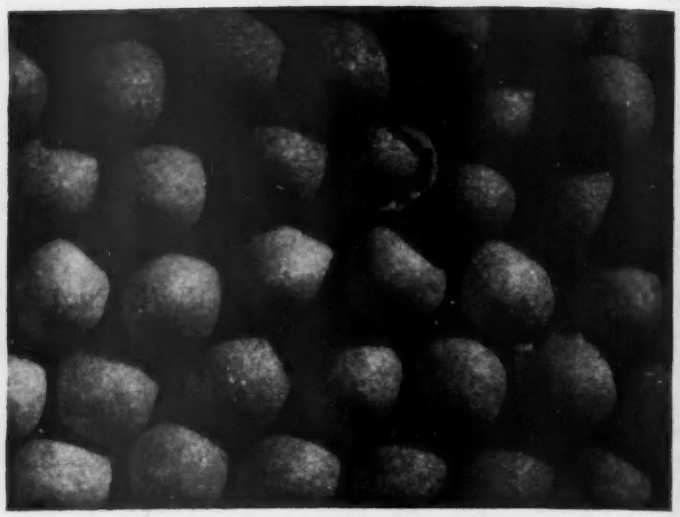

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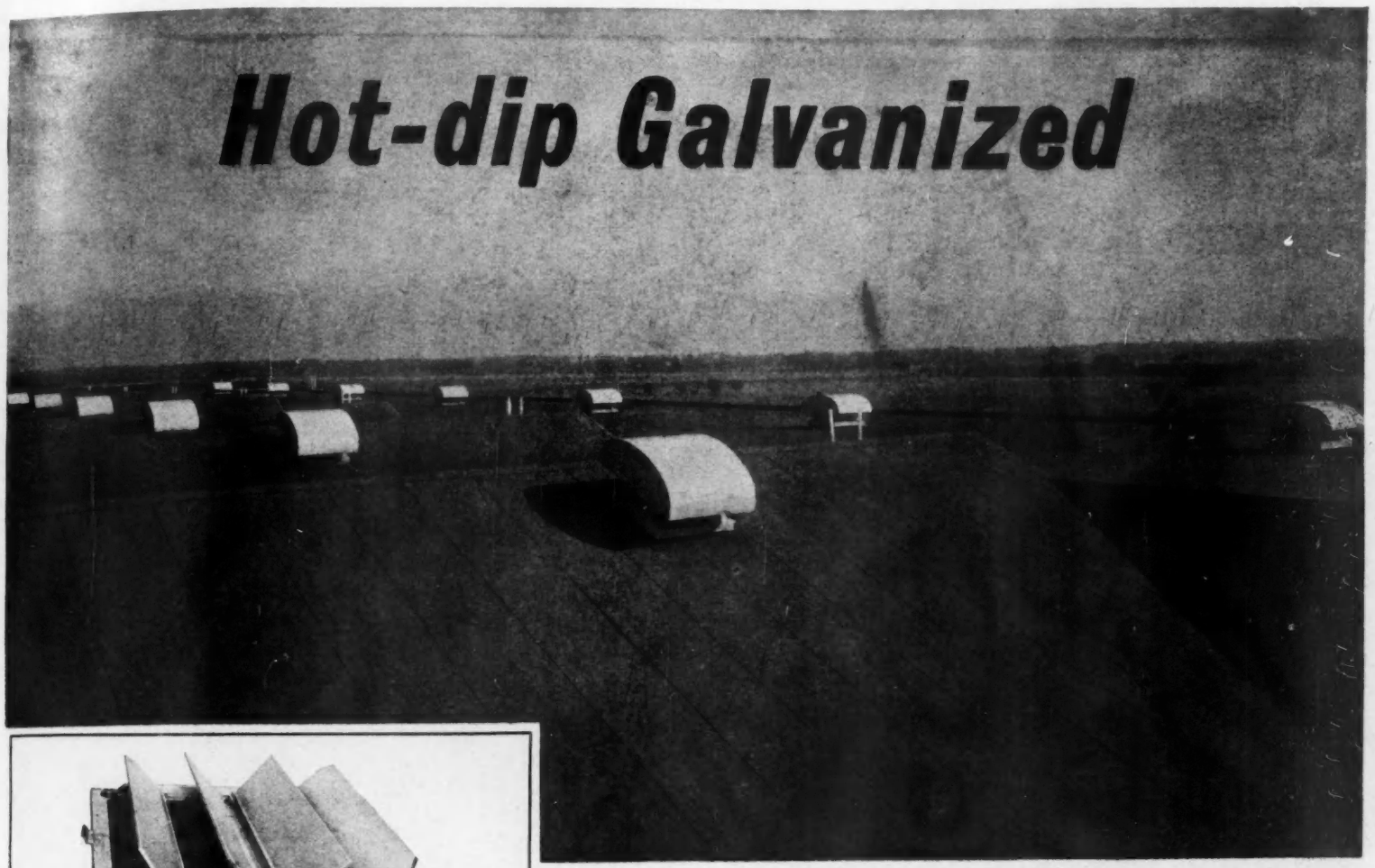
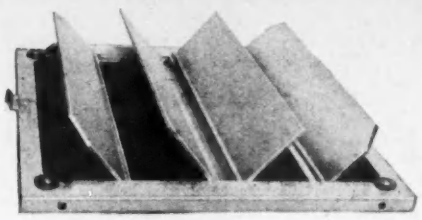


Section of the vast new plant for Priestman Bros. Ltd. Hull, where 70 'BROOKS' 30" and 24" units are installed. Consulting Architects and Engineers — Monro & Partners.



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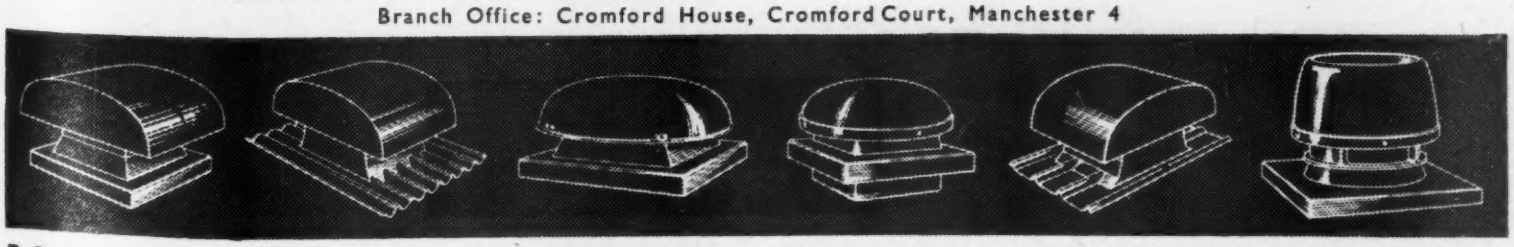

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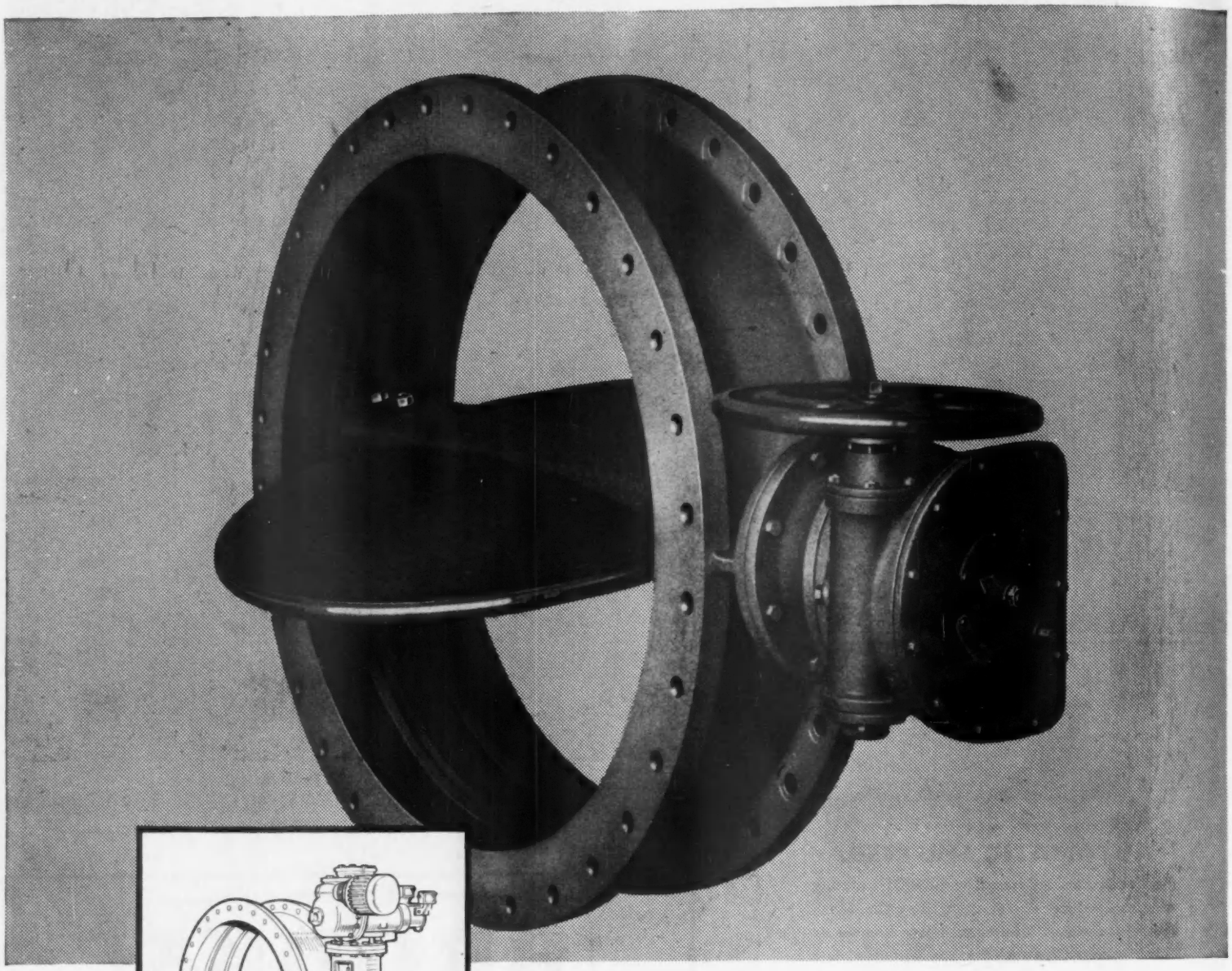

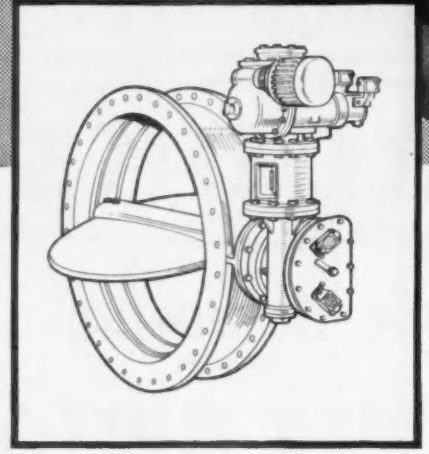

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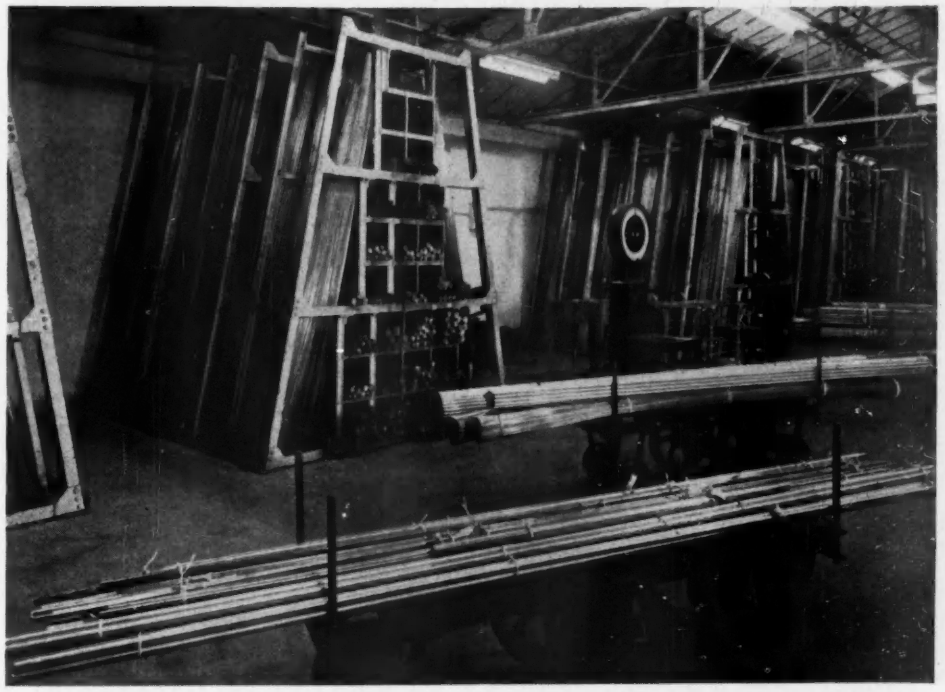

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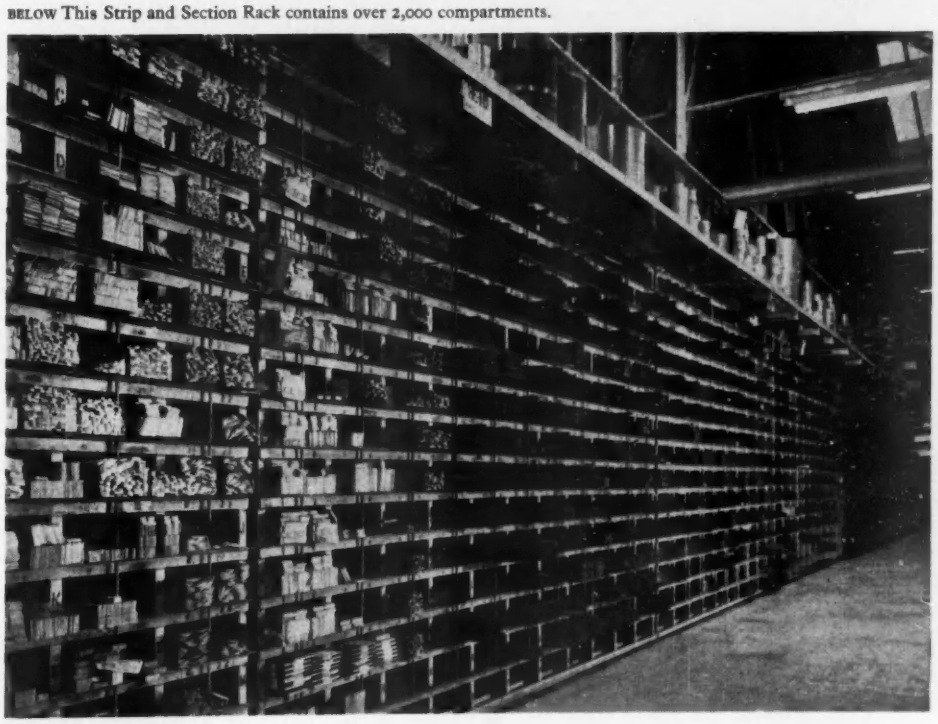

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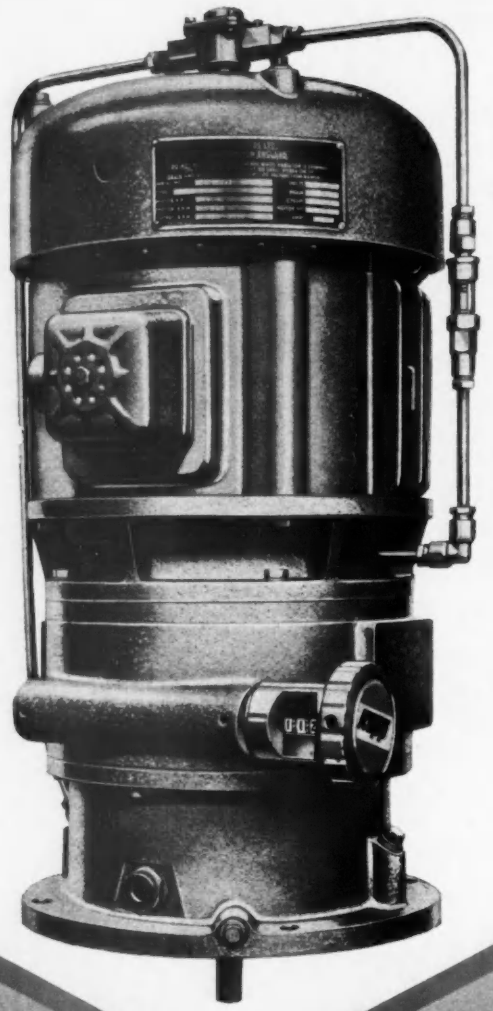

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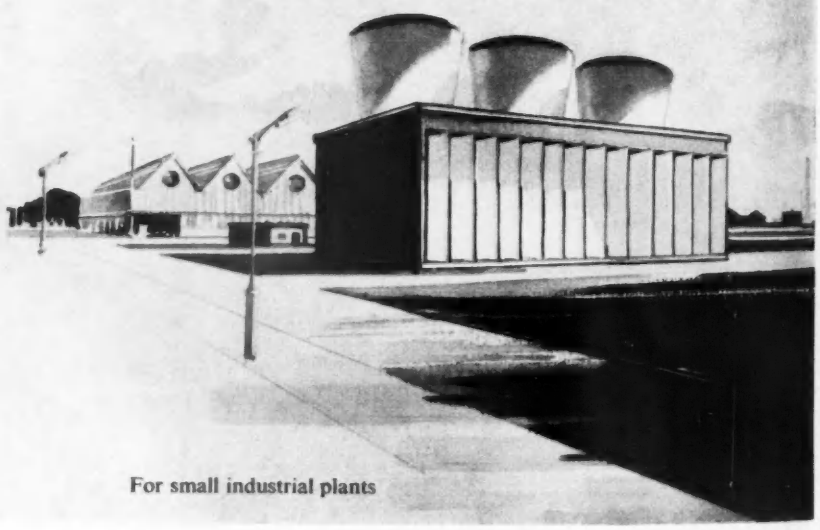

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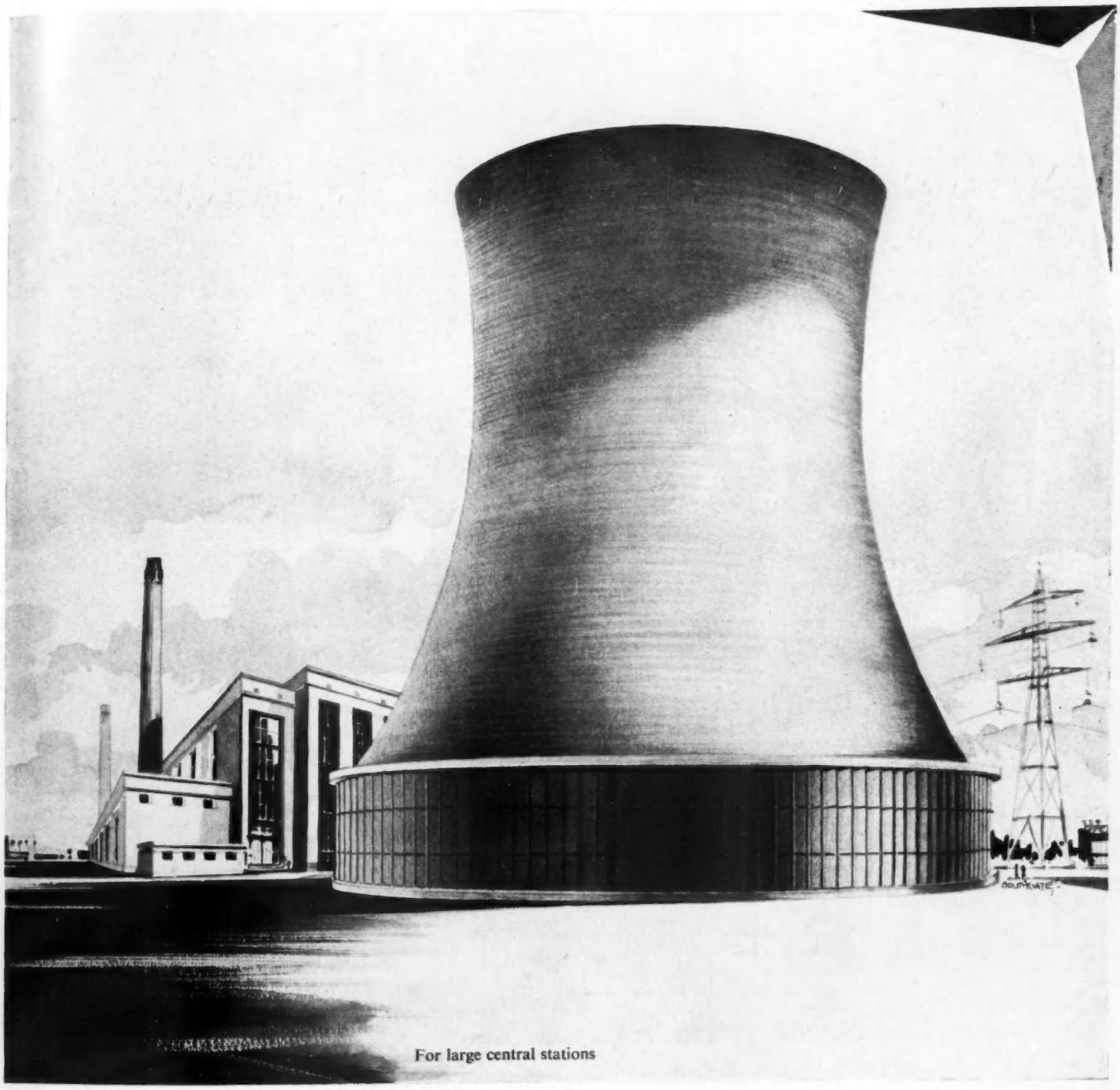

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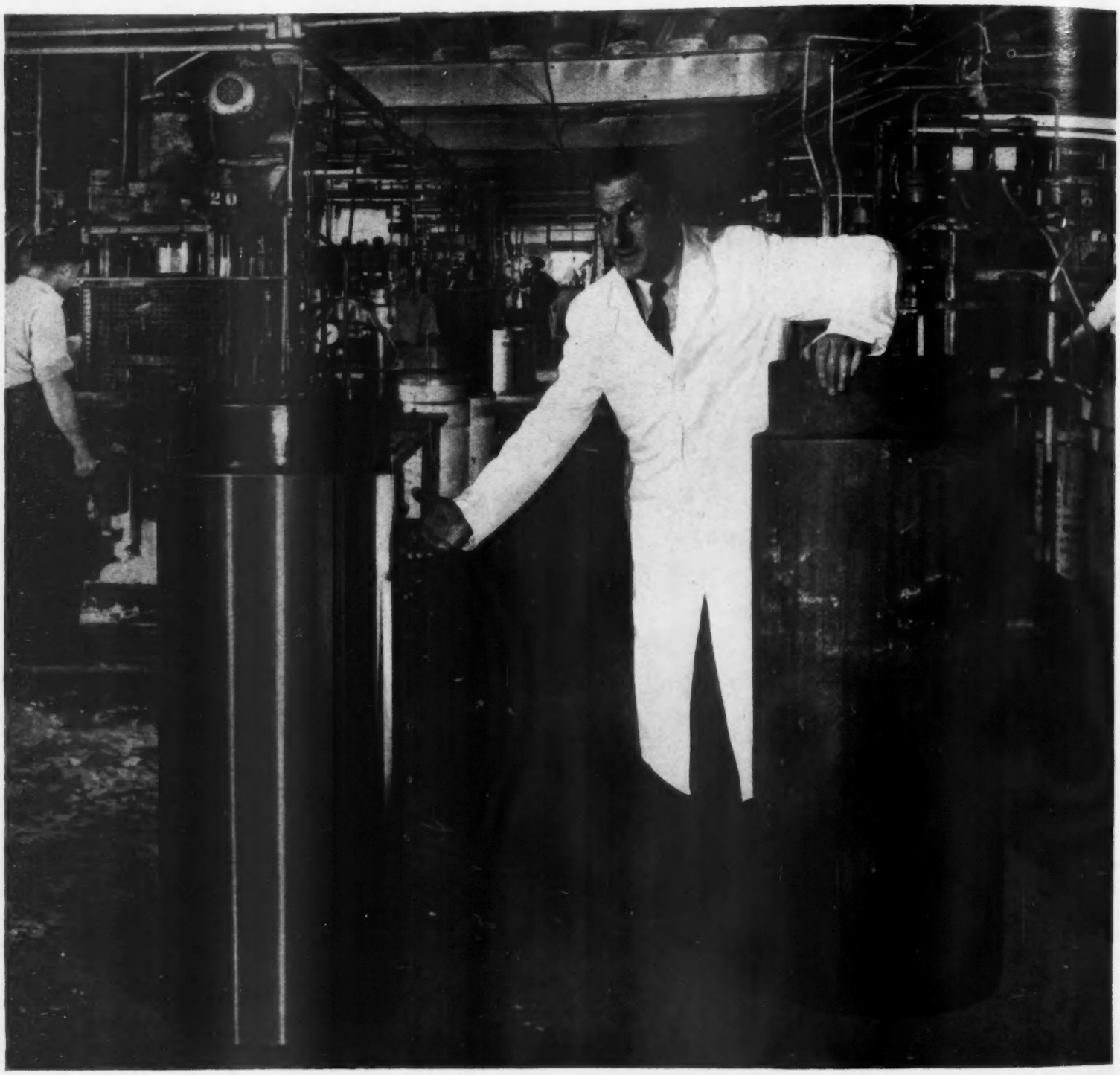

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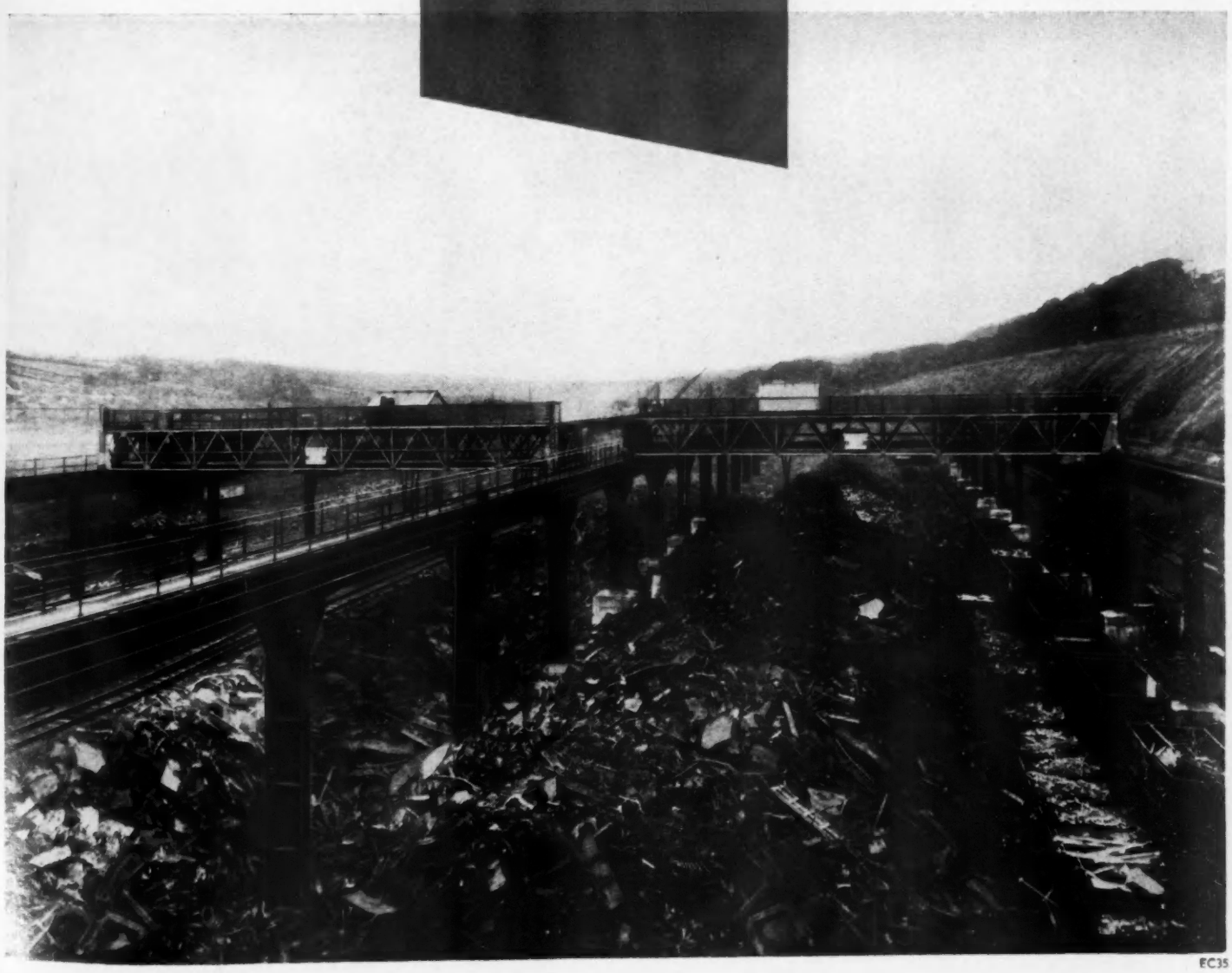

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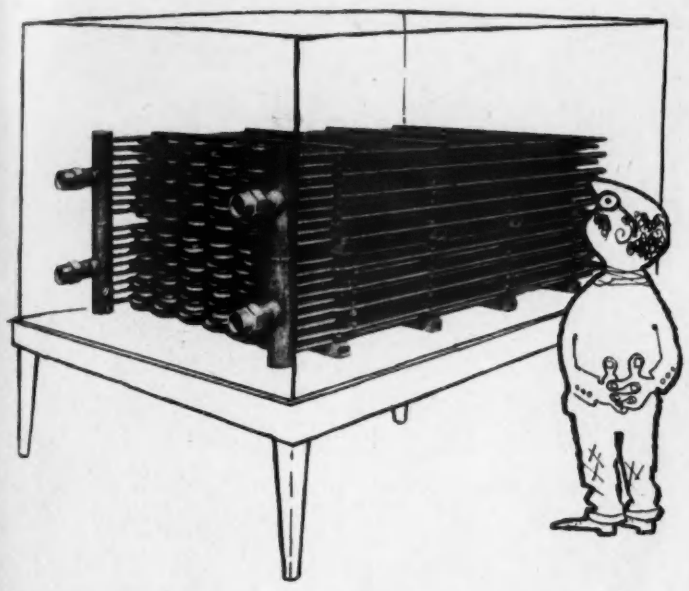

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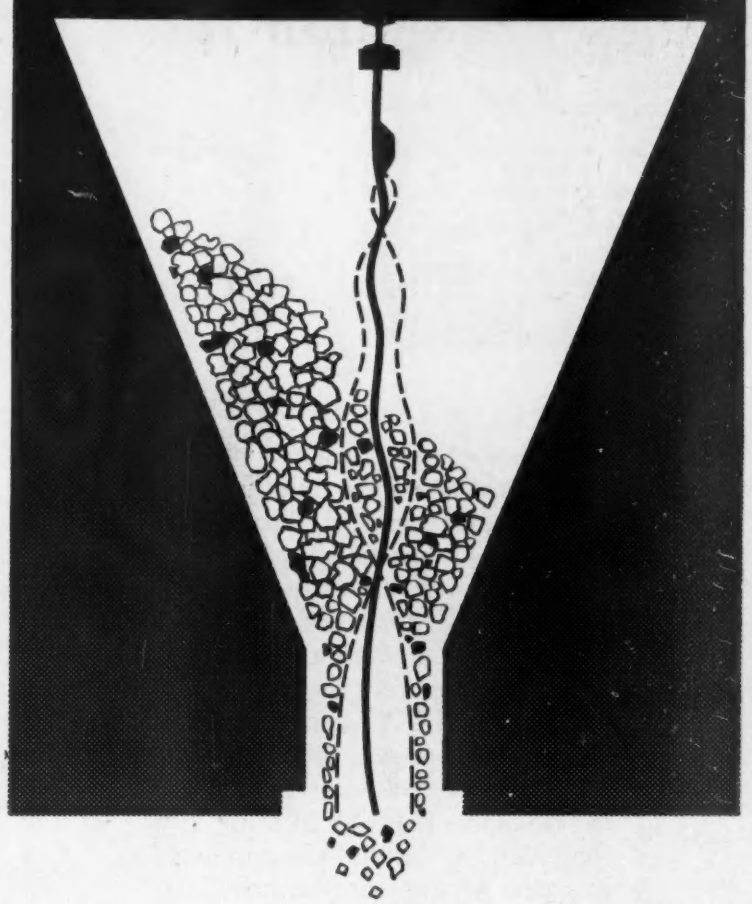

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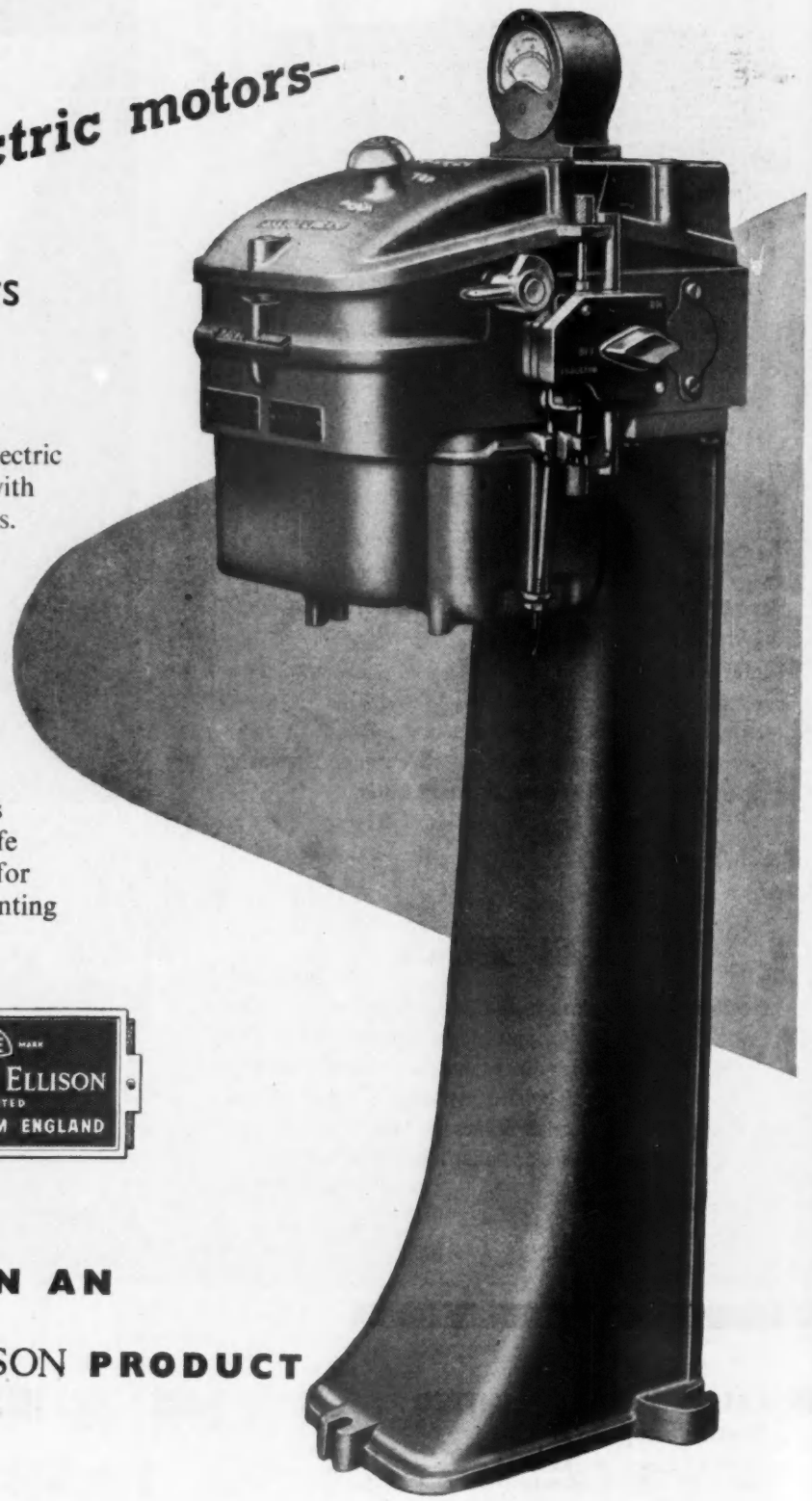

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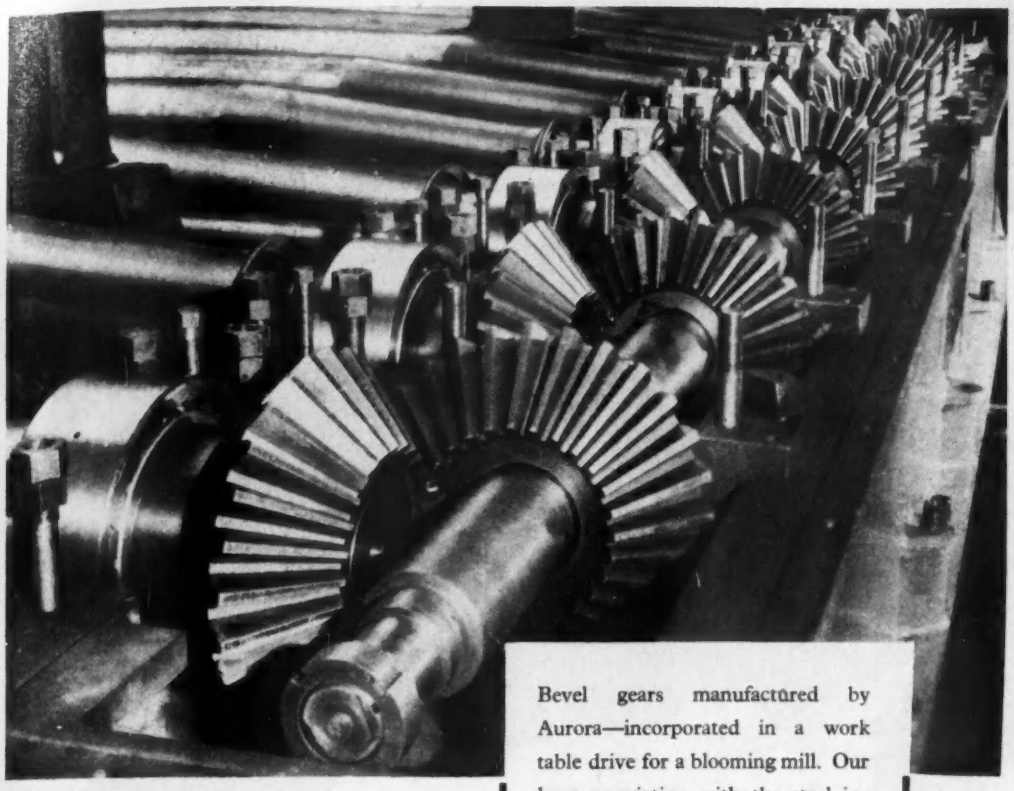

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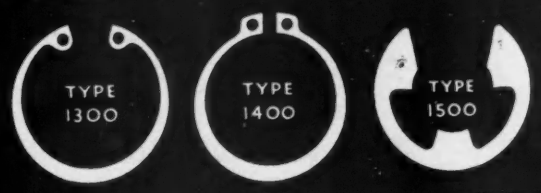

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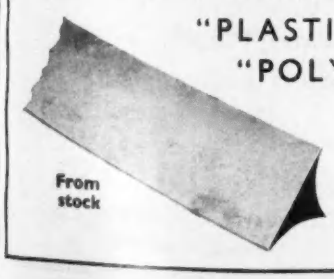

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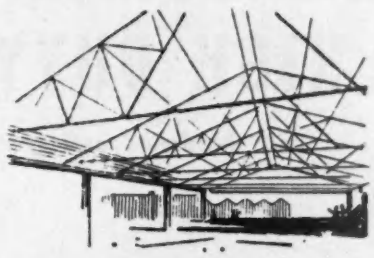

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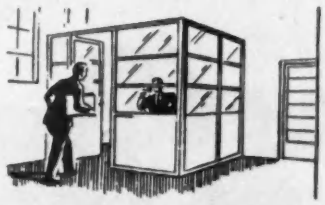

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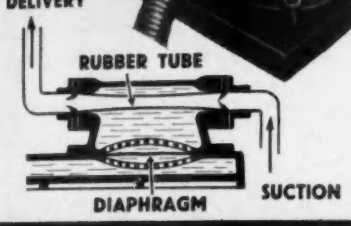

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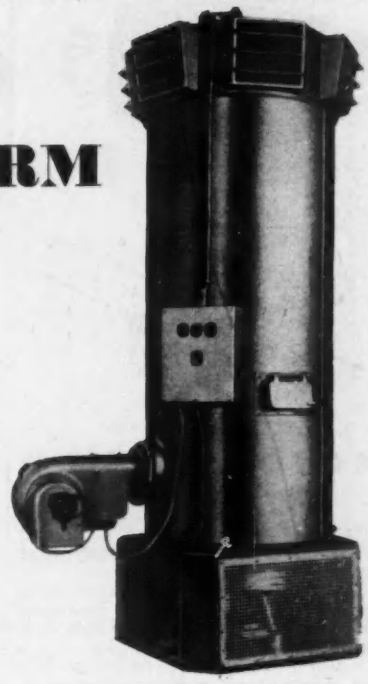

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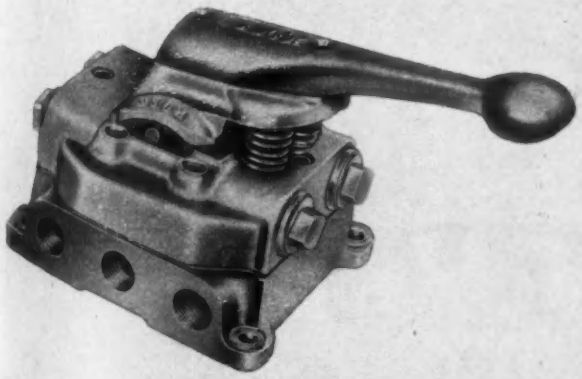

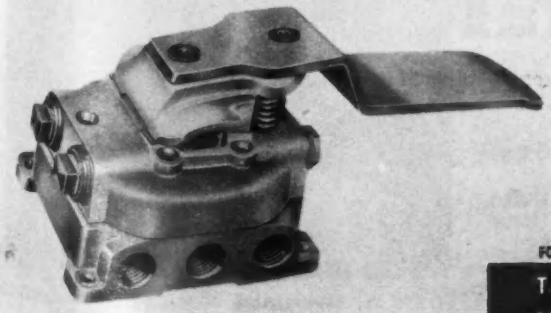

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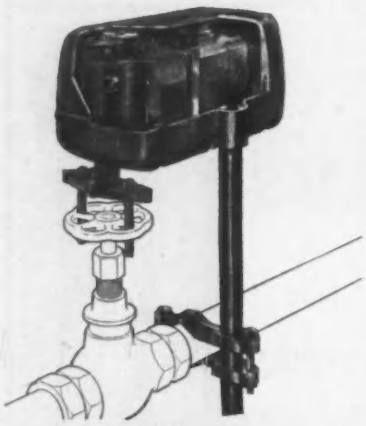

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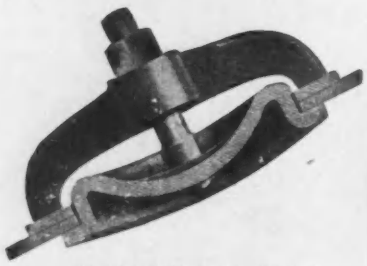

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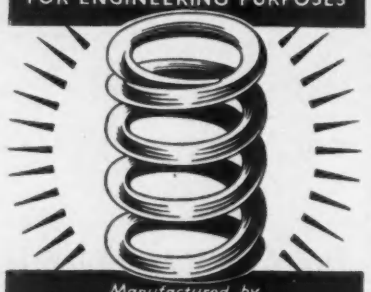

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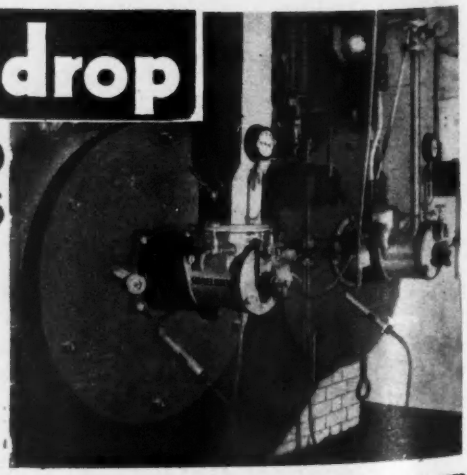

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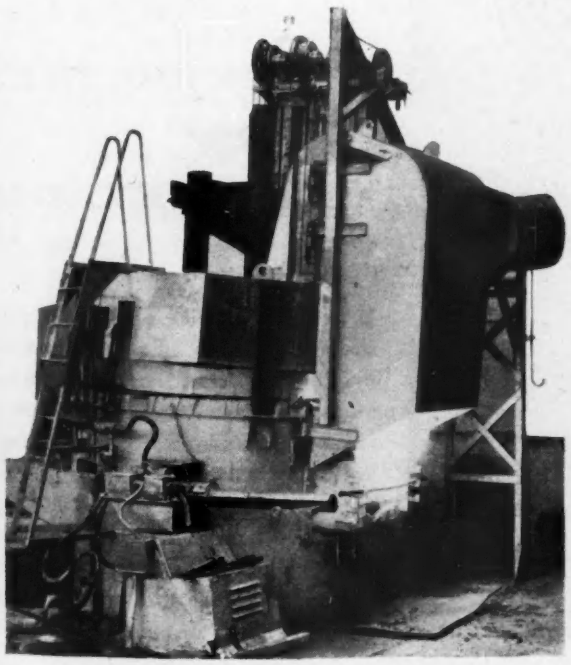

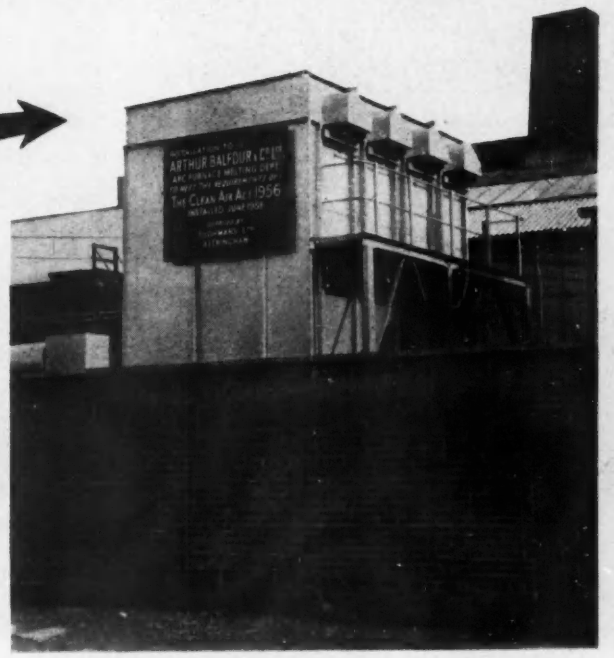

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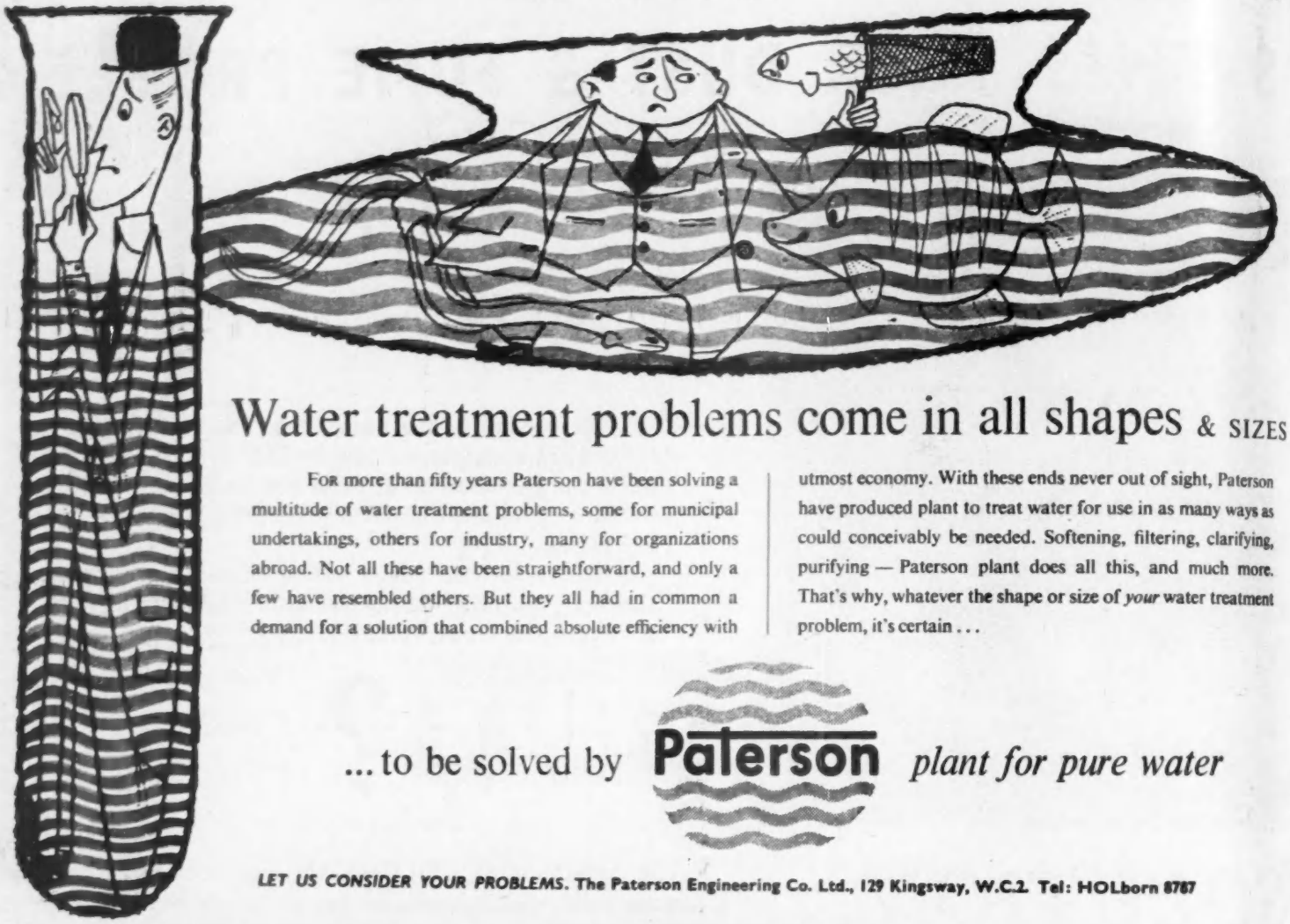

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No. 5390 MAY 15, 1959 VOL. 207

NUCLEAR POWER AT SEA

Engineers, we think, will have been strongly excited by the Admiralty announcement last week that seven groups of firms in addition to the Atomic Energy Authority have designs in being for marine nuclear reactors. Several things are exciting about the announcement. First is the fact that firms outside the original consortia are taking an interest in the manufacture of nuclear ship's machinery. It can be assumed, we suspect, that they have perceived how very much bigger the market for marine propulsion units may be than for large land plants ; and furthermore that orders for marine propulsion machinery are unlikely to specify that much of the plant shall be built abroad, as is true of land plant. Secondly it is encouraging to note how much attention has been given to reactor systems other than the gas-cooled. That latter system was originally chosen for development by the U.K.A.E.A. for well understood and very good reasons. But it was always appreciated that the gas-cooled graphite-moderated reactor might not turn out to be suitable for the generation of the relatively low powers required for ship propulsion. At the same time it is very desirable that it should be discovered whether it can be adapted for that purpose ; so that we are glad to notice, amongst the eight systems under study, that three are advanced gas-cooled reactors.

Though no wholly novel system has been explored it is made very clear by the information that has reached us that the several differing systems—no two are exactly alike—have been subjected to really detailed feasibility studies, another indication, no doubt, that the firms concerned foresee a profitable future in the manufacture of nuclear marine power plant. All the systems, including the five not based upon advanced gas-cooled practice, are founded upon existing practice in some respect in that at the very least a research reactor of a similar kind is in operation or building somewhere. Claims are made for some that given the word to go, a power plant could be in service at sea within three years. All make hopeful, even if probably optimistic, estimates of capital costs and running costs to suggest that nuclear power for ships should be an economic proposition. For the gas-cooled types these estimates relate to powers of the order of 25,000 h.p., a power low enough for the engines of a large modern tanker or a high-speed passenger liner.

Elsewhere in this issue we begin an article giving as much information as the Admiralty and the firms concerned are willing to reveal about the respective systems. All, it will be observed, possess different characteristics in terms such as weight, size, capital and operating costs and other technical factors. The claims for each have now to be assessed by a technical sub-committee which the Civil Lord's committee is setting up ; and all will need especially to be examined for safety. The latter is an important point because no country is likely to feel happy about admitting a nuclear-powered ship to its ports and canals unless assured that a collision, or the sinking or stranding of the ship, will have no consequences more dangerous than those arising from accidents amongst conventional ships. No doubt the Admiralty in pursuing its purpose to develop nuclear propulsion will be forced economically to select only one or two of the proposed systems for financial support. But we dare to hope that the studies already made may prove sufficiently exciting to bring forth more support from industry than there is at present. For it would be of great advantage to this country if it could take the lead in the development of nuclear plants able to generate moderate and small power outputs economically ; and it would be singularly inappropriate for our maritime and shipbuilding nation to leave to others the prime part in the development of economic nuclear marine reactors.

MODESTY IN SPACE RESEARCH

The policy announced by the Prime Minister last Tuesday for Britain's contribution to space research will, of course, not satisfy those who have been advocating an all-out effort by this country to compete with the U.S.A. and the U.S.S.R. Nor will it satisfy those who believe this country to be now so far behind in the design of rockets and of the kind of instruments needed for space research that it would be useless for us to attempt anything since we would merely be duplicating what had been done elsewhere already. But in fact it seems to us a sensible, moderate policy. There is an immense amount of scientific research to be done by the use of instruments mounted in satellites orbiting around the earth at heights of a few hundred miles. It is believed, reasonably enough, that British scientists pursuing researches of their own could have something substantial to contribute to the discoveries that will be made, to the elucidation of those discoveries, and to the correlation of various discoveries one with another. Since the Prime Minister was unquestionably impressed by the unanimous opinion of distinguished scientists that there is room for British participation in space research and that it is highly desirable that there should be British participation, we find it difficult to believe there is real foundation for any other belief. The primary intention appears to be that British-built satellites shall be flung into orbit by American rockets. By this means British scientists would be able to contribute to space research without involving the country in the high expenditure involved in developing British rockets for the purpose and diverting some of the already limited effort we can afford to put into the development of missiles, into the construction of space rockets. But there is always uncertainty about international co-operation and it may well prove, in the longer run, unsatisfactory to depend upon the Americans (or the Russians) to place our satellites in the orbits in which we want them placed at the times we want them launched. The Government, very wisely, therefore, is initiating design studies about the modifications to existing British missiles which would be necessary to fit them for placing satellites of substantial size into

orbits. As for our part we believe that British engineers are, and should continue to be, playing a part in advancing theoretical and practical knowledge of the design and operation of rockets we cannot help hoping that the scientists will, in fact, find that they cannot get all they desire from American co-operation. The Americans are to be approached almost at once by a team under the leadership of Professor H. S. W. Massey, to see how much co-operation could be made available. The Prime Minister also referred to co-operation with Commonwealth countries. General supervision of the research programme is to lie in the fields of operation of the Lord President of the Council and the Minister of Supply. More detailed work will be supervised by the British National Committee on Space Research set up by the Royal Society. No one will be able to say that Britain will be squandering money on the project. The Prime Minister referred to it as costing hundreds of thousands of pounds rather than millions. That is certainly modesty in space research.

FLYING SPEEDS IN CIVIL AVIATION

On the previous occasion that we expressed ourselves under this title—some twenty-five years ago—it appeared to us that aeronautical engineers would not have to consider speeds in excess of 600 m.p.h. during their lifetime, for it was clear that a radically new form of propulsion would be necessary to encompass higher speeds. But now the American Convair "600" with ducted fan engines—just such a radically new form of propulsion—is fast approaching consummation, and we cannot escape a re-appraisal of the question. Last week the Society of British Aircraft Constructors issued a policy statement, quoted on page 775, from which we learn that it has been afforded a sight of the report of the Supersonic Transport Aircraft Committee, and it can be inferred from a recent statement of the Minister of Supply that the members of the Society will be similarly privileged. Meanwhile, there is no sign whatever that the report will be published in the normal way. Presumably national security is deemed to be involved. Obviously there must be benefits to be derived by aircraft firms from studying, designing, or developing such a machine. But has it been overlooked that other engineering techniques would benefit from the wider dissemination of up-to-date information on this subject ? It is, of course, possible that we exaggerate the importance of the influence of aeronautical research and practice in stimulating advances in other fields. Possibly—it would be very natural of it to do so—the British aeronautical industry is at present exaggerating it in the hope thereby of persuading the Government to maintain the level of its expenditure on aeronautical research. But there can, we think, be no doubt that it is of some value. Thus we think it desirable the report should be published.

The Society's statement makes an allusion to the prestige value of a supersonic airliner and, in our view, underestimates it. We could agree much more wholeheartedly with its belief that no aircraft constructor in the United States of America has capital at risk in a supersonic commercial aircraft if the word "yet" was added. Enterprises with devices such as "Look to Lockheed for Leadership" will hardly leave the development of supersonic airliners to the one or two firms who build equivalent military machines. The Society's statement is again less than complete in leaving tenable the view that the Society's members might harvest some of the prestige at stake. We have already seen the Soviet "Badger" given a larger fuselage to become, until recently, the only jet airliner in service, and the Soviet "Bear" given a larger fuselage to become the heaviest and longest-ranged of all civil aircraft. Can it be doubted that the only supersonic airliner in the world will, not long hence, be a Soviet "Bounder" given a larger fuselage ? The leaders of the Soviet state are already reported to be preparing to gather the prestige that will go to the first aircraft to fly on nuclear power, possibly a much more important achievement. It is perhaps a pointer to the disillusioned valuation placed on prestige by the Society's members that none of them apparently proposes to essay this latter feat, even though to do so might have redeemed the prestige lost when the great "Princess" flying boats were cocooned.

An encouraging difference between this and the previous occasion when we observed that British commercial aircraft were becoming eclipsed in respect of speed is that to-day many avenues of progress, other than the one of increasing speed, can be seen to be open or opening. Prominent among these is the possibility of reducing costs, so as to bring about orders-of-magnitude increases in passenger and freight traffic offering. Another, less interesting to the great nations of North America and Asia, but very important to the British Commonwealth, is that of flying with laminar boundary layer flow so that long ranges could be attained with much smaller aircraft, that would be able to operate services economically which attract too little traffic to justify the use of larger conventional aircraft. Also attractive to countries where the cost of conventional aerodromes is becoming beyond their ability to pay for them is the prospect of short- and vertical-take-off-and-landing, which might well permit the regularity of operation necessary to make a service self-supporting without demanding expensive installations on the ground. And there is even the course to which, last week, the old-established firm which was the first in the world to fly a jet airliner committed itself, that of building an aircraft such as already exists but with the details of construction adapted for different requirements.

VITAL STATISTICS

At the beginning of last year, the Board of Trade introduced a new scheme for the collection of statistics relating to the engineering industries. All firms, except the very smallest, engaged in mechanical and electrical engineering are now asked for returns of their total deliveries and orders on hand, "with export deliveries and orders separately distinguished" and the whole "analysed under a number of headings for broad categories of products." A sample of firms, including all the largest, are asked for monthly returns while others make their returns quarterly. From these returns, the Board of Trade is able to provide monthly estimates of the changes in the activity and order position of the group of industries as a whole. There was a time, of course, when managements of most engineering firms would have questioned the value of such an exercise. They would have declared, quite firmly, that they knew how they stood and were well able to assess the state of the industry of which they were a part. Dickens in his heyday could take a tilt at education built on statistics, figures and facts ; he did not at all approve of Gradgrind, the "man of realities, facts and calculations!" But that day is long past. The science of statistics has become essential equipment in assessing the state of the nation. Statisticians are no longer "Gradgrinds" even though their labours may not always produce results that are

quickly understood. Inevitably there are occasions when statistics inspire the mischievous thought that the situation to which they relate could be either a little worse or a little better than it really is !

We hasten to commend, however, what the Board of Trade has described as its new scheme of engineering statistics. The first of these new statistics were published at the end of last week. Their particular merit is in the fact that they are as up to date as possible. At a time like the present when there is expectation of expanding output and consumption, following a measure of recession, it is helpful to have a reasonably clear picture of trends in production, exports and orders. Information of this kind is necessary in the consideration of short-term and longer-term development plans. The main details of this set of engineering statistics are summarised on page 780 of this issue. They show that in the first two months of this year both home and export business tended still to decline a little. Competition from other countries has obviously to be taken more than ever into account. The fillip given by the Chancellor's budget can help towards meeting that competition successfully, if the engineering industries—including the appropriate trade unions—are determined to transform the recent downward trend into an upward movement.

NEW BROOMS IN D.S.I.R.

The second report of the Council for Scientific and Industrial Research makes it abundantly clear that, whether or not for the better, the change in the organisation for controlling research in the Department of Scientific and Industrial Research is having the proverbial effect of the new broom. Over the last two years fresh critical thinking has been applied to every activity of the Department, with results that are being energetically applied. In particular the economics committee has been studying the adequacy of research in the U.K. both in general and in particular fields. Perhaps because the Government is impressed by all this activity the proposals made by the Council to the Treasury about expenditure in the next quinquennium running from 1959 to 1964 have met with success. The Department's expenditure is to rise by 70 per cent as compared with the previous five-year period, from £36,000,000 in 1954–59 to £61,000,000 in 1959–64. These figures may appear large. But in fact an annual expenditure likely to rise from about £9,000,000 in the present year to £14,000,000 in 1963–64 is very small relative to research expenditure on armaments.

Some of the changes being introduced must necessarily lead to heartburning. In our view the Council is right to close down the Fuel Research Station, to transfer some of its work to the new Warren Spring Laboratory, and to discontinue the remainder. But on the human side this means, of course, that work in which certain people were taking a deep interest comes to a sudden end or, maybe, is transferred to other hands. Even at stations that are not to be closed down there may be similar heartburning. For the Council, through the separate Boards for each laboratory or through the smaller steering committees for each laboratory which it seems rather to favour, is tending to suggest that the Department's resources should be concentrated on fewer projects. There is a natural tendency for research discoveries to open wider horizons and for research establishments to wish to follow up along all the possible lines of progress thereby revealed. But if adequate resources are to be applied to any given project this centrifugal tendency has to be resisted. Additionally, the Council has it clearly in mind that there is a difference between the kinds of research that should be undertaken by the Department and kinds that can much more appropriately be undertaken by industry either through the research associations or in individual firms. It is also endeavouring to prevent duplication by attaining a clear perception of the field covered by each of its laboratories.

Amongst other activities which well deserve attention here there should be noticed the Council's belief that valuable ideas may well exist in some of the smaller industrial concerns of this country which they themselves cannot afford to investigate. Smaller firms should note that the Department is ready to consider any such propositions put to it. It also appreciates that at the other end of the scale there may be research and development projects which even large and wealthy firms or industrial organisations cannot afford to finance either because the scale is too large or because the returns are too speculative. Again the Department is ready to consider any projects suggested to it, whatever the scale, provided it seems likely to lead to results of value to the nation as a whole. Finally in this review of the Council's report we should refer to its obviously increasing concern to get research results properly applied. It is, we think, very clear that industry is often unaware for lengthy periods after a discovery has been made that it has in fact been made. More effort is needed than just publication of the results in technical papers before institutions. We note that, in the case of the Mechanical Engineering Research Laboratory, recently re-named the National Engineering Laboratory, two deputy Directors are to be appointed, one of whom will have the primary duty of fostering closer relations between the Laboratory and industry. That seems to us a very wise development.

The Engineer—100 Years Ago (MAY 13, 1859)

"Water Gas"

"The production of hydrogen gas by the decomposition of water is well known, but for illuminating purposes it is equally well known that the flame from pure hydrogen alone is worthless, though for heating stoves it has been successfully applied. When jets of lighted hydrogen are made to burn in a grate filled with loose fragments of platinum foil, a very cheerful-looking fire is produced, and this is well-known to the public under the name of Bachoffner's Polytechnic fire, from its frequent exhibition a few years since at the Polytechnic Institution, by Dr. Bachoffner. Hitherto the expense of producing hydrogen gas for heating purposes has prevented its being manufactured on a large scale.

"Many patents have, however, been taken out during the last few years, for producing hydrogen gas from water, and bringing it into combination with rich gases derived from oil, resin, tar, naphtha, Cannel coal, and other materials yielding highly illuminating gases .... The processes do not differ greatly, but almost the only one which appears to have been carried out practically on any tolerably large scale, is that of Mr. White, under whose patent several towns in the north, and factories in Lancashire, have been lighted with gas manufactured from water, combined with the gas from resin or Cannel coal. Some small works have been erected at St. Ives, on Mr. Webster's patent. Dr. Frankland, at Manchester, made a large number of experiments in reference to this gas on works erected by Mr. White, at the mills of Messrs. Clark and Co., with a view to ascertaining its illuminating power and its cost as compared with that derived from coal. The result of these experiments was in favour of the water gas, both as to illuminating power and cost. Notwithstanding this, from some cause or other, its use has not extended."

Nuclear Reactors for Marine Propulsion

No. I

Last week we published an Admiralty announcement that a number of firms and consortia had proposed designs for nuclear reactors for ships. The merits of these designs are to be assessed by a technical sub-committee of the Civil Lords Committee. We have secured particulars of some of these designs.

G.E.C./SIMON-CARVES REACTOR

CONTRARY to most other designs put forward for marine propulsion, the G.E.C./Simon-Carves design is based on the gas-cooled graphite-moderated reactor already well-established in Britain. Major advances in fuel-element design, however, are expected to result in much higher outlet gas temperatures, and very much reduced overall size of the reactor system. The following is a brief description of the main elements of the designed installation, supplied to us by The General Electric Company, Ltd., Magnet House, Kingsway, W.C.2.

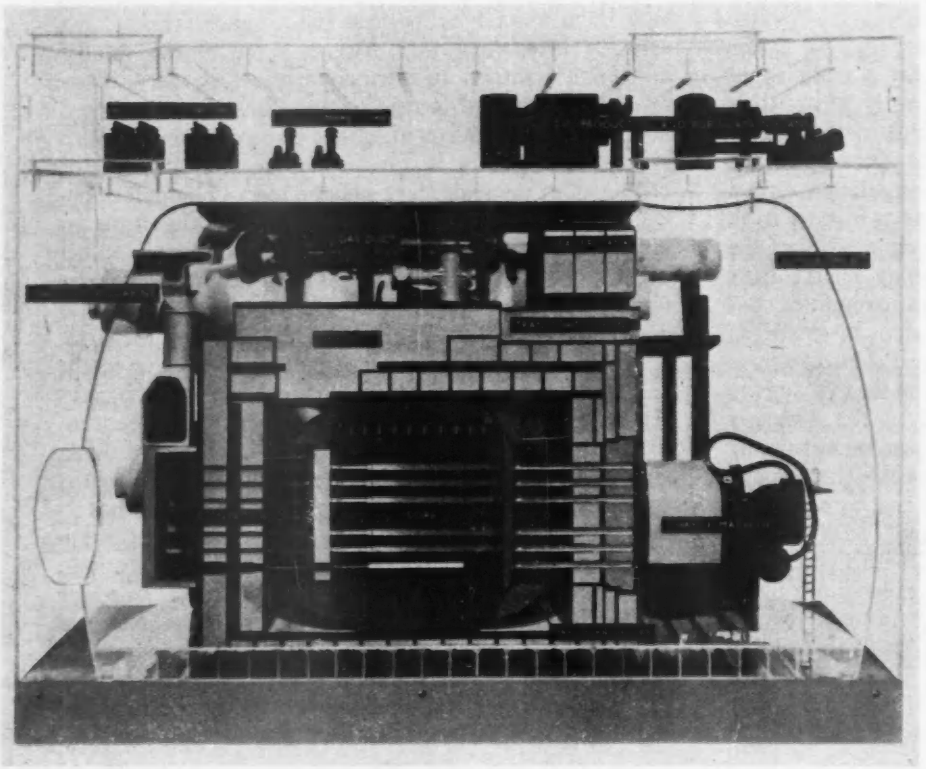


Fig. 1—This is a view of a sectioned model of a G.E.C./Simon-Carves marine propulsion reactor as originally proposed. It is worth noting the compactness of the unit inside the containment vessel and the positioning of auxiliary equipment between the decks above

The fuel elements are of completely new design, consisting of slightly enriched uranium dioxide canned in stainless steel. They are provided with graphite sleeves as in other G.E.C. reactors.

The graphite core is made up of blocks held together and supported by a surrounding steel structure. The fuel-element channels extend horizontally right through the core and are interspersed with control-rod channels, also horizontal.

The reactor pressure vessel is a horizontal cylindrical vessel with domed ends. Charge/discharge standpipes are at one end, and control-rod and emergency access pipes at the other. The main gas ducts are connected through suitable nozzle forgings.

The main shielding structure surrounds and supports the pressure vessel and is made from steel plate. The construction is of an essentially cellular nature and the voids are filled with purified water to act as a neutron shield. A concrete plug is used at the charge/discharge end for the standpipes. The shielding water is circulated through an external cooling circuit.

The primary coolant ducts carry the high-pressure carbon-dioxide gas coolant between the reactor vessel and the four steam-raising units. Suitable butterfly isolating valves, safety valves, bellows expansion units, supports, and restraining damper systems are provided.

Turbine-driven circulators are mounted at the aft ends of the s.r.u. vessels.

Four steam-raising units are mounted on the outside of the main shielding structure above the reactor. Each has economiser, evaporator, and superheater sections. Internal headers are used and all steam/water connections pass out through the specially shaped head at the forward end of the unit.

The charge/discharge machine is a pressurised and shielded unit which can be connected to any one of the charge/discharge standpipes, there being one of these for each fuel channel. It is possible to charge fuel with the reactor under load and the ship at sea.

The control system consists primarily of a series of neutron absorbing tubes which can be inserted into the graphite core to control the nuclear reaction. A separate emergency shut-down system is provided in the form of additional rods housed inside the normal control tubes.

The secondary gas circuits include the CO_2 generation and storage equipment (make-up CO_2 of high purity is generated from fuel oil) and CO_2 filtration and drying circuits. A separate circuit is provided to cool fuel elements in the charge/discharge machine.

The burst cartridge detection equipment enables a continuous check to be maintained on the conditions of the fuel elements in each channel. It is similar to existing systems.

The containment vessel is a truncated cylindrical vessel resting on a flat grillage. It houses all the nuclear and steam raising plant with the exception of the steam drums, and has the minimum possible number of penetrations. The necessary filtration and cooling plant is supplied and integrated into the system for the cooling of the main shield water. Personnel would not usually enter the containment vessel during normal running of the plant, although it is quite safe for them to do so if necessary.

The control room is the "nerve centre" for the operation of the power plant. Controls and indicating/recording instruments are mounted on the reactor control desk and further instrumentation is grouped on a separate control panel. Two further rooms off the main control room house the safety equipment and B.C.D. instrumentation respectively.

Table I provides figures for estimated sizes and weights; and a number of artists' drawings, Figs. 1 to 3, show the general arrangement proposed. In Fig. 4, supplied by the firm, comparisons are made of the weights of conventional and nuclear marine machinery.

TABLE I—*Estimated Sizes and Weights*

Core diameter	7·5ft
Core length	6·75ft
Pressure vessel :	
Inside diameter	14ft
Weight	125 tons
Bottom support grid :	
Length	56·5ft
Weight	200 tons
Steam-raising unit, diameter	7·5ft
Charge machine, length	12·5ft
Containment vessel, weight	243 tons
Total weight of installation	2400 tons
Total containment volume	68,000 cu. ft
Total thermal power produced in the reactor	150MW

GENERAL ASPECTS OF THE DESIGN

It is one of the principal aims of The General Electric Company to produce an economic " package " power reactor with an output in the range 30MW–100MW electrical, with the major primary circuit components capable of shop fabrication and transportation to site. The smaller sizes of such reactors would be suitable for marine propulsion; the design submitted to the Admiralty is thus representative of the company's thought on the development of power reactors in general.

In adopting the general design for ship-board use a number of special factors had to be taken into consideration, among them the following:

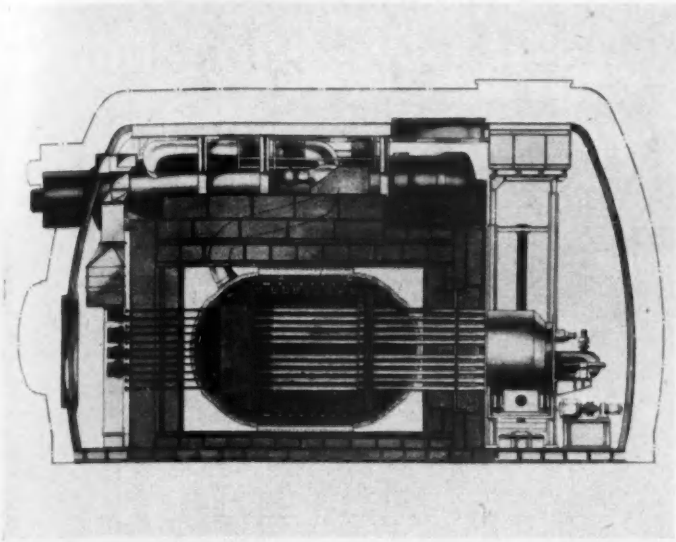
(1) The need for a compact, minimum-weight unit.

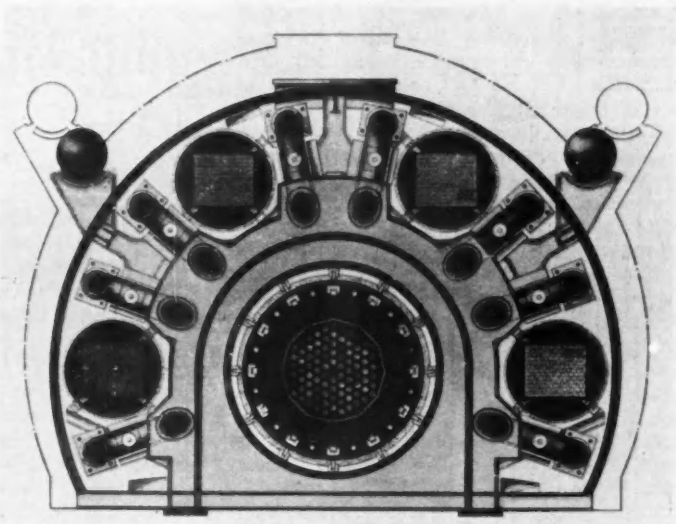
(2) The need for a low centre of mass.

(3) A limited, fixed space in which to house the reactor.

(4) The necessity to withstand high vertical and horizontal accelerations.

(5) The need for an overall design suitable for integration into the general structure of the ship.





Figs. 2 and 3—(Left) Longitudinal section through the improved version of the G.E.C./Simon-Carves marine propulsion reactor, with an outline of the origina design for comparison. The reactor is in the centre surrounded by the water biological shield. The charge/discharge machine is on the right; standpipes lead from it to the horizontal fuel channels in the core. Control rods enter from the left. At the top is one of the four steam raising units, with its hot gas duct. The saving of space relative to the earlier design suggests that further developments may lead to further economies. (Right) Transverse section through the improved version of the G.E.C./Simon-Carves marine propulsion reactor, with an outline of the original design for comparison. The reactor core is in the centre, supported inside the pressure vessel, which is in turn supported inside the container for the water biological shield. The four steam raising units are spaced around the outside of the shield, each with its associated hot and cold gas ducts. The ducts are curved and run inside the shield for some distance so as to prevent direct leakage of radiation from the core. The whole system is enclosed in the containment vessel, except for the steam drums which can be seen outside it.

In initial surveys of small reactors for both marine and land-based installations a formidable array of reactor variants was faced. As a basis two criteria were adopted; first, and most important, that the system chosen should be based as far as possible on current reactor technology, and secondly, that it should have a high development potential, with the ultimate objective that it should be economically competitive with conventional power.

In Britain, both in the Atomic Energy Authority, and latterly in industry, a very considerable operating and design experience has been built up, based almost exclusively on the gas-cooled graphite-moderated reactor system. Fundamentally, this new proposal differs only in one major respect from the Calder Hall type of reactor—the fuel. Stainless steel cladding and uranium allow higher operating temperatures with, at the same time, a much greater temperature safety margin than in the current land-based power reactors. Although British operating experience with this fuel is at present lacking there is a wealth of published American data and the Atomic Energy Authority is to use uranium dioxide in the Advanced Gas Cooled Reactor now under construction.

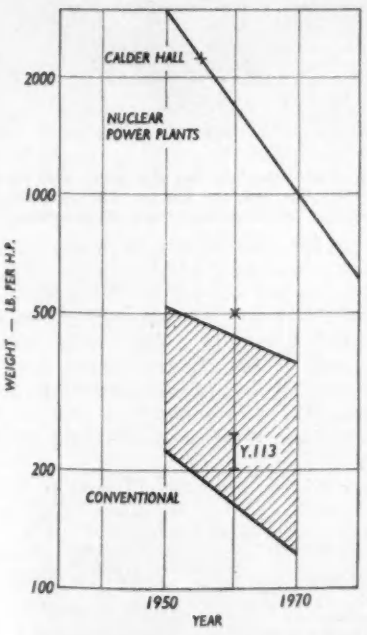


Fig. 4—Comparison of the weights of conventional and nuclear marine propulsion units.

The top line shows an extrapolation from present land-based nuclear stations, and the cross at 500 lb/h.p. a recently proposed nuclear marine installation. The lower limit of the shaded area shows the approximate trend of conventional ship propulsion machinery, and the upper one that with the additional weight of fuel oil. The line marked Y.113 shows the original (upper) and revised (lower) weights of the G.E.C./Simon-Carves marine propulsion unit. All weights are in pounds per shaft horsepower

Further Development

The high development potential of the new reactor is strikingly illustrated by the progress made in ashort time since the design was first frozen for the study. Safety analyses carried out on digital and analogue computers by the designers showed that the system is safe and very much higher fuel ratings than initially envisaged would be acceptable. The performance of the fuel element, which has been and is being intensively developed by The General Electric Company, has allowed advantage to be taken of this. A number of engineering improvements have also been incorporated, and the combined effect of these is to reduce the size and weight of the system considerably. An idea of the magnitude of this reduction can be obtained from the accompanying diagrams (Fig. 4).

A further potential development of great importance is the use of fuel cans made from completely impermeable graphite. The fuel elements are eminently suited to this type of canning, which would not only reduce the enrichment required in the uranium dioxide but also raise the maximum temperature allowable, enabling development of the reactor to keep pace with the development of turbines in this respect.

HAWKER SIDDELEY ORGANIC MODERATED SHIP'S REACTOR

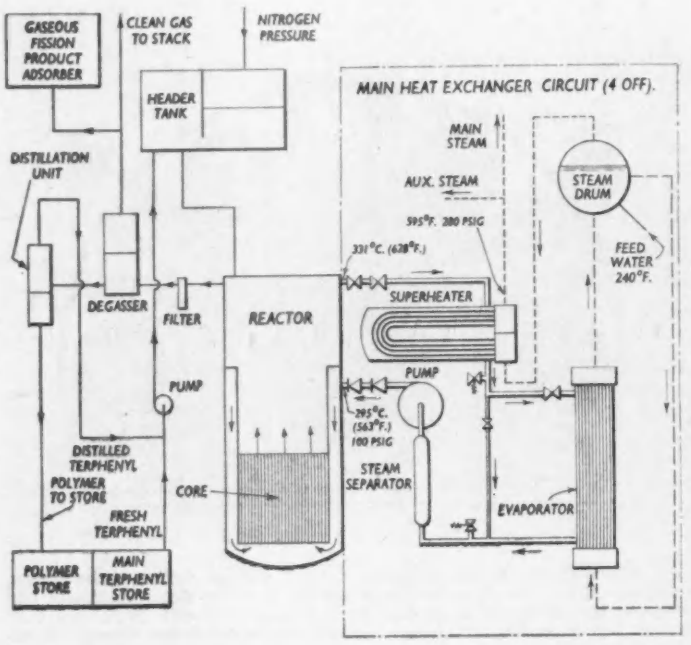
A detailed design study of an organic moderated reactor has been prepared for the Admiralty by the Hawker Siddeley Nuclear Power Company. This reactor, in the form proposed (Figs. 5 and 6) is thought to be suitable for use in conventional merchant ships requiring high power. With modifications in output and the incorporation of known design developments, it is expected it would achieve lower than conventional operating costs for medium size commercial ships, for instance, tankers having a tonnage of 40,000.

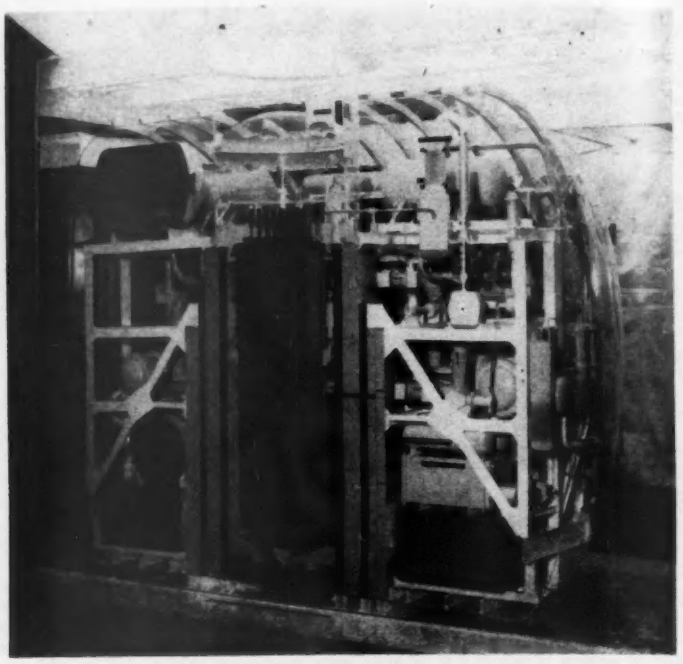
The basic philosophy of this kind of reactor is fairly well known and it offers the advantages particularly suitable to ship propulsion of having comparatively small size and being essentially simple. The liquid coolant, terphenyl, to be used, is non-corrosive and has a low vapour pressure. These properties result in a system pressure of less than 100 lb per square inch and the utilisation of mild steel in the construction of the reactor vessel and primary circuit. Conventional equipment may be used in this circuit and, due to the lack of induced activity in the coolant, access to this circuit is possible whilst the reactor is in operation.

This particular reactor has been designed to utilise uranium oxide fuel elements canned in stainless steel. It was necessary to postulate that sea-water might enter the reactor core as a result of catastrophic collision or sinking and the utilisation of uranium oxide and stainless steel offers a very corrosion resistant combination against sea-water attack. For a 17,000 s.h.p. ship the enrichment required in the uranium oxide fuel is 1·4 per cent ($2C_0$). The fuel elements are made up of two sections to allow for end to end fuel cycling and each element consists of a bundle of nineteen fuel rods as illustrated in Figs. 7, 8 and 9. Fuel cycling can be arranged at intervals of one to two years to suit the operator. The Jason research reactor * now under construction at Langley will be used to determine the detailed nuclear characteristics of the proposed fuel element bundles illustrated. Jason will also be employed to evaluate the best combination of elements for the shielding of the ship's reactor.

Detailed studies of the O.M.R. on the company's analogue computer installation show that it has a negative temperature coefficient under all burn-up conditions and that the reactor is consequently self-stabilising. It is expected that these control characteristics will allow O.M.R. powered ships to manœuvre at least as easily as a conventional ship. It will be possible to use plutonium enrichment with natural uranium when

* The Engineer, April 10, 1959, page 582.





Figs. 5 and 6—(Left) Outline of organic moderated reactor system. (Right) This model of the O.M.R. shows the core, the boiler and the chemical processing plant

sufficient plutonium becomes available.

A criticism levelled at the organic moderated reactor is that the moderator/coolant suffers from irradiation damage; however, the cost of replenishment is calculated to be only 0·07d. per shaft horsepower hour. It is expected that with increasing demand for terphenyl, its production cost and consequent replacement costs will be reduced. Terphenyl can in certain conditions be inflammable but this can be overcome quite readily by the use in the reactor compartment of nitrogen-rich air in which terphenyl cannot be ignited. This air will have an oxygen content of 15 per cent and it is breathable without the use of special apparatus.

The O.M.R. is amenable to development in various ways, each of which brings about a reduction in operating costs. Beryllium canning could be used for the fuel when this has been proven, and this would bring about a reduction in the fuel enrichment required. A graphite reflector can be employed and this would reduce operating costs by 2 to 3 per cent. A considerable improvement in cycle efficiency can be obtained by the utilisation of a two-zone core whereby coolant passed through the outer lower flux zone of the core is raised to a higher temperature than that of the bulk of the coolant and this high temperature coolant is then passed to the superheater. Steam conditions of 710 deg. Fah. and 480 lb per square inch absolute can thereby be achieved giving a cycle efficiency of 24·8 per cent. This results in a 9 per cent reduction of fuel costs for an increase of only 2 per cent in terphenyl replacement costs. It has been shown that high heat transfer rates, possibly up to nucleate boiling, can be achieved and this would permit increases of output in a given sized reactor of up to 60 per cent.

An installation of the type of O.M.R. proposed to the Admiralty but having an output of 17,000 s.h.p. would cost approximately £890,000 and weigh about 1300 tons. This latter figure compares with the weight of over 4000 tons for boilers and oil fuel bunkage for an equivalent conventional tanker. Operating costs for an O.M.R. of such an output and suitable for a 40,000-ton tanker are about 5 per cent higher than conventional operating costs. With development and plutonium enrichment, however, the operating costs of such an O.M.R. tanker are expected to be about 5 per cent less than those of a comparable conventionally powered ship.

Fig. 7—Assembling the fuel element bundle inside the barrier tube to form the complete fuel element section

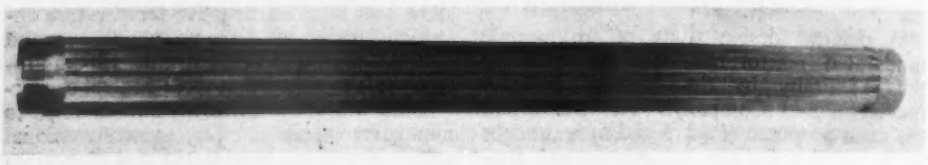


Fig. 8—Exterior view of an assembled fuel section. Two such sections form the complete fuel element, so allowing, end to end, recycling of the fuel bundle

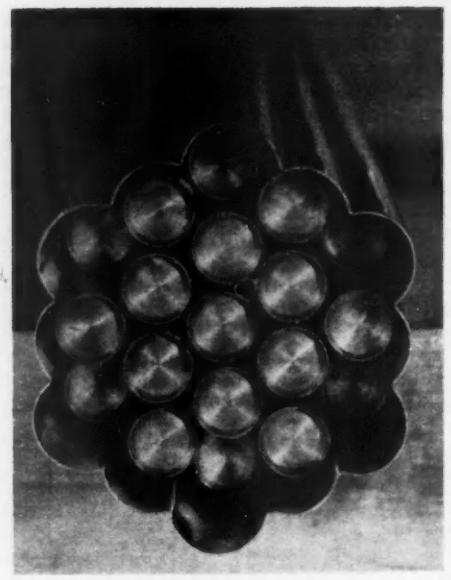


Fig. 9—End view of the fuel element showing the nineteen fuel rods and the barrier tube separating the coolant and moderator zones of the terphenyl

TABLE II—*Brief Specification of a* 17,000 *S.H.P. O.M.R. Installation*

Reactor output, megawatt thermal	56
Core diameter	5·2ft
Fuel height	5ft
Fuel canning	stainless steel
Fuel enrichment	2C$_0$
Number of fuel elements	264
Number of fuel rods per element	19
Xenon override	Yes
Number of primary loops	2
Coolant temperatures:	
Bulk: inlet	295 deg. Cent. (563 deg. Fah.)
outlet	331 deg. Cent. (628 deg. Fah.)
From outer zone: inlet	295 deg. Cent. (563 deg. Fah.)
outlet	405 deg. Cent. (761 deg. Fah.)
Steam conditions at T.S.V.	480 p.s.i.a. 710 deg. Fah.
Overall cycle efficiency	24·8
Weight of containment and contained equipment	1300 tons

(To be continued)

Temple Mills New Hump Marshalling Yard

No. 1

One of the most important localities in the Eastern Region of British Railways for marshalling freight traffic has now been completely modernised and ranks as the most up-to-date yard in Great Britain. In this article and a succeeding one, the new layout and equipment is described, noting the co-ordination between the mechanical operation in the yard and the signalling of the approach lines.

ON the railways of this country the siting and layout of marshalling yards in the past has to a great extent reflected the volume of relatively short-distance freight hauls, characteristic of British railway operation, with local specialised traffics. With few

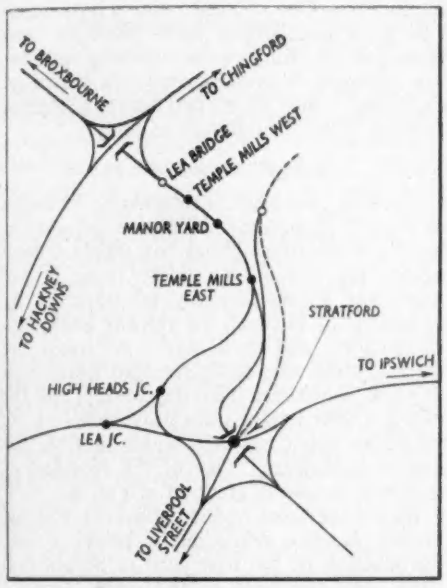


Fig. 1—Environs of Stratford and Temple Mills

exceptions the yards date from a time when road transport was not a serious competitor, and when the overall time in transit was not a vital matter in securing the business. There was a tendency to lay down sidings on spare land, or on land adjacent to key junctions, and many small yards, of twenty sorting sidings or so, were operated successfully, though slowly, by yard pilot engines, and brakesmen to check the speed of running wagons. At larger centres there might be three or four such small yards that had grown up on land previously vacant, and much time was spent, and occupation of running lines was involved, in shunting and transfer trips, as was inevitable through some lack of co-ordination between the working of the adjacent yards. To-day, these small yards are becoming obsolete, through the desirability of running heavier and faster freight trains conveying block loads, and through the manifest advantages, both economical and operational, of having large, concentrated, and mechanised yards capable of handling 3500 to 4500 wagons a day.

The freight traffic facilities on the Great Eastern Line, Eastern Region, British Railways, north of Stratford, provide an excellent example of the most modern trend in railway operating strategy and tactical technique. In its historical associations this district provides examples of the piecemeal way in which the plant was expanded, with the years, without any overall policy being formulated to develop and co-ordinate the various local yards. From a very early stage in railway development in this country, the main line of the old Eastern Counties Railway, striking north from Stratford, up the Lea Valley to Bishops Stortford and Cambridge, formed a major artery of supply of coal, manufactured goods, and agricultural produce from East Anglia and the North to London. In the open ground of the Lea Valley, between Stratford and Tottenham, there have been marshalling yards since the year 1880; every year from 1880 onwards to 1893 there were applications for further siding accommodation and in this piecemeal expansion at least £45,000 was spent. Eventually there were no fewer than ten yards of varying sizes in the area indicated in Fig. 1. The scheme recently

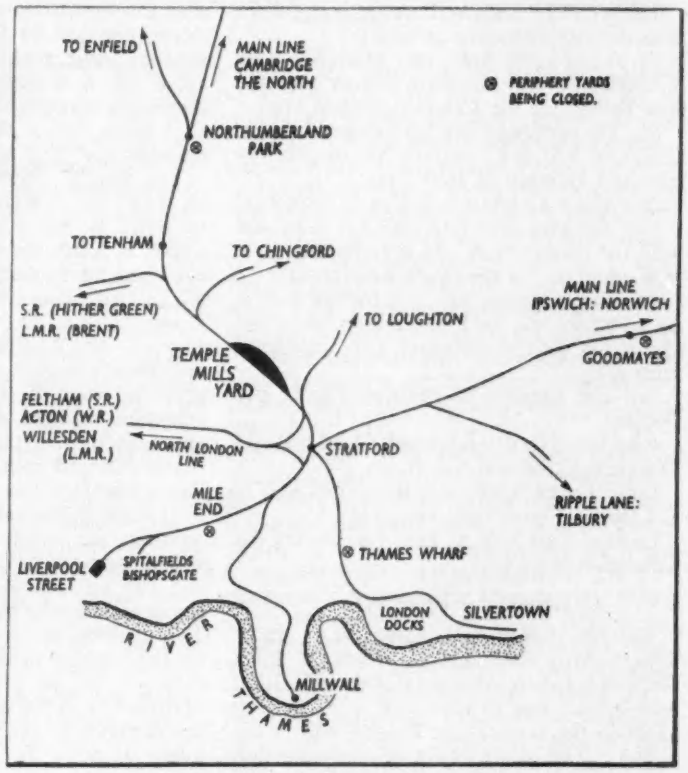
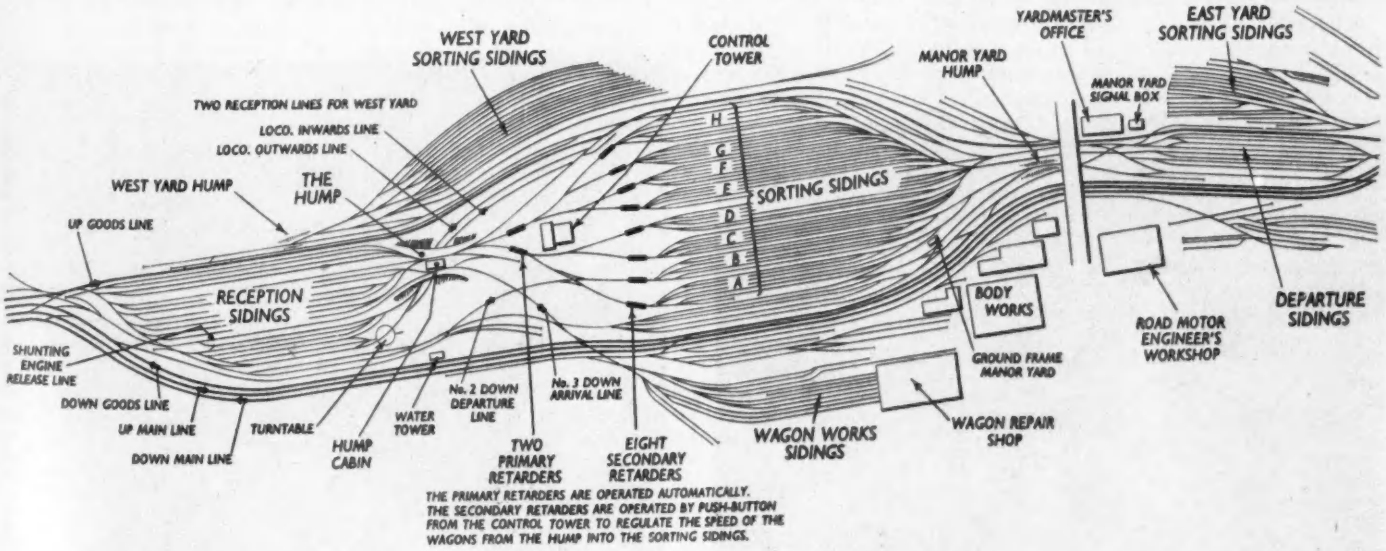


Fig. 3—Temple Mills in relation to Eastern Region lines



1. "Mixed" trains arrive at Reception Sidings over a variety of approach lines.
2. The wagons are uncoupled, singly or in groups.
3. The wagons are then shunted over the hump and run by gravity into the appropriate Sorting Sidings according to their destinations.
4. After the wagons are coupled the newly made-up trains are taken to the Departure Sidings, thence to Up or Down Goods or Main Lines.

Fig. 2—Temple Mills marshalling yard

completed has concentrated all this disjointed and largely unco-ordinated marshalling into one new yard; while the co-ordination of traffic working has been furthered by a comprehensive re-signalling of the approach lines regulating the operation into and out of the new yard, at both the eastern and the western extremities.

The further diagram, Fig. 3, shows the location of Temple Mills in relation to the Eastern Region lines as a whole in the London area, and indicates the position of the smaller " periphery " yards, which are being closed. Their traffic is now being concentrated upon Temple Mills. Six old signalboxes (Chobham Farm, Loop Junction, Loughton Branch Junction, Lea Bridge, Temple Mills North and Temple Mills South) have been replaced by two panel-operated boxes (Temple Mills East and Temple Mills West) and one mechanically-operated box (Manor Yard).

Traffic Flows

Temple Mills deals with traffic to and from nine distinct directions as under:—

(i) The North and the Midlands (via Whitemoor), the Hertford branch and the Lea Valley, via the Cambridge main line;

(ii) The exchange with the former Midland, G.C. and S.E. & C. sections, via the Tottenham and Hampstead Joint Line;

(iii) The Chingford and Enfield branches;

(iv) The exchange with the G.N. Line and with the former G.W., L. & N.W. and L. & S.W. sections, via the North London Line;

(v) The exchange with the former L.B. & S.C. section, via the East London Line, and the traffic with Bishopsgate and Spitalfields terminals;

(vi) The imports of Millwall Docks and Poplar;

(vii) the North Woolwich Line, Royal Docks, Beckton and Silvertown;

(viii) The exchange with the former L.T. & S. Line via Forest Gate Junction;

(ix) the East side of East Anglia, via the Colchester main line.

Operating Principles

The new mechanised marshalling yard at Temple Mills embodies the fruits of much study devoted to the theory of the operation as a whole, and to the working of existing yards in this country, in France, and in the U.S.A. The prime object of mechanisation was to reduce to almost negligible proportions the very large labour force previously needed in large yards, where the checking and braking of wagons was done by men running alongside. The " throughput " from some yards of this latter kind was remarkably high, though at a cost in wages, and damage to goods arising from rough shunts or derailments. The introduction of hump yards, with relatively steep gradients and single-stage retardation, by power-operated rail brakes, was effective enough in making possible a drastic reduction in manpower; but the operators, however skilled, could not always judge the running of a wagon so as to apply precisely the amount of brake force in the retarders required so to reduce speed that enough momentum remained to carry the wagon to the end of the siding into which it was routed, and to bring it gently into contact with wagons already there. To avoid the risk of too violent an impact, the retarder operators tended to apply too much brake force, with the result that the wagons stopped before reaching the end of the available space in the sorting siding. In consequence, after a complete train had been humped, the locomotive had to follow, and spend considerable time pushing wagons down. To avoid this a process of retardation in two stages was recommended, and in the new yard at Temple Mills there are two primary retarders and eight secondaries.

The general layout of the new yard is shown in Fig. 2, and an important feature to be noted is that while the general flow of traffic is from the west end, the yard is equipped for two-directional working. The No. 2 Down Departure line and the No. 3 Down Arrival line, with their directions of running, should be particularly noted. There are twelve reception sidings for trains to be propelled over the hump. Access to these reception sidings, while mainly from the approach lines at the west end of the yard, is also obtained from the No. 3 Down Arrival line. The single line over the hump leads into forty-eight sorting sidings. The two primary retarders are situated just beyond the first pair of diverging points, or " King " points, and the secondaries are beyond the third group of diverging points, or " Jack " points. This diagram also shows the provision made for the working of light engines, so as to be clear, as far as possible, of all humping operations. Advantage has been taken of the elevation of the line at the crest of the hump to carry the " Loco. Inwards " and " Loco. Outwards " lines clear beneath, in a burrowing junction.

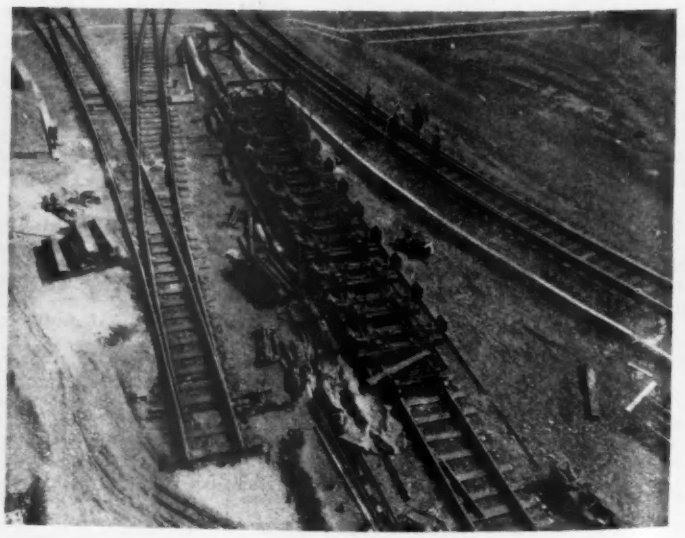
A photograph taken from one of the floodlighting standards during construction work, reproduced in Fig. 4, gives a good impression of the general appearance of the reception sidings, and the approaches to the hump from those sidings. Within the main yard there is a small layout called Manor Yard, which serves the twelve westernmost sorting sidings in the main yard by means of a small hump at the south end of these sidings; and there are also two single-ended subsidiary sorting yards. One of the latter, the East Yard, serving suburban stations on the eastern side of the G.E. network, has been formed out of the former Loughton Yard, but the other, the West Yard, for dealing with traffic to stations on the western side of the G.E. suburban network, is entirely new.

In a short single-ended sorting siding, which has been provided for brake vans, there is installed a special 24in stroke hydropneumatic buffer stop, capable of dealing with a brake van colliding at 12½ m.p.h. This kind of buffer stop is an innovation in a marshalling yard. Another new feature is the siting of the reversing spur for the humping engines beyond the crown of the hump. This allows two humping engines to work with the minimum of delay.

Constructional Work

The new yard was constructed in the midst of the old yard, and this latter continued to handle traffic throughout the whole course of the reconstruction. Every stage in the work had to be carefully programmed by collaboration between the railway engineers, contractors, and yard staff. At times the track layouts were being changed from week to week, sometimes from day to day, and for nearly a year freight train movements in the yard area were conducted under hand signalling arrangements. One of the retarders is shown in course of erection in Fig. 5.

By far the most restrictive period was the twelve months immediately prior to the introduction of the new yard in September, 1958. By that time in the whole area of Temple Mills, of the various groups of sidings available, only the West Yard bore any resemblance to the conventional idea of a marshalling yard and yard shunting was accomplished only by constant improvisation. The old Temple Mills North and South signalboxes had been demolished, and for almost a year train movements in the yard area took place under hand signalling arrangements and special instructions, which had to be adapted week by week as the work progressed.



Figs. 4 and 5—(Left) View taken during construction of the yard, looking over the hump and reception sidings. (Right) Construction work; one of the retarders in course of erection

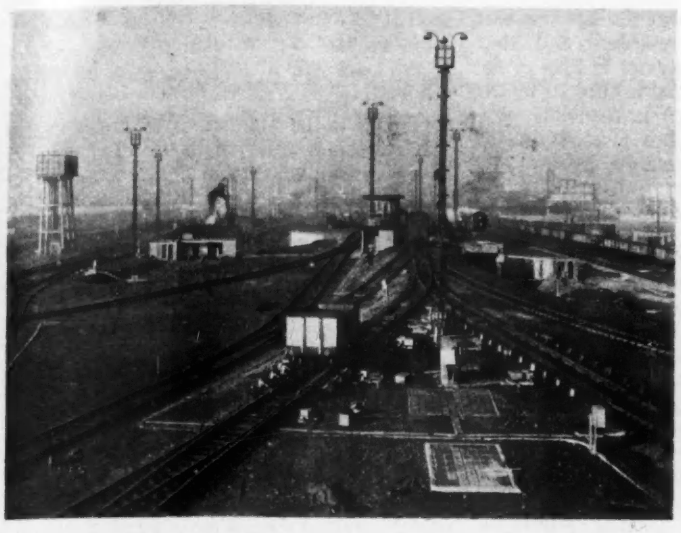


Fig. 6—Hump from control tower with wagon passing through one of the primary retarders

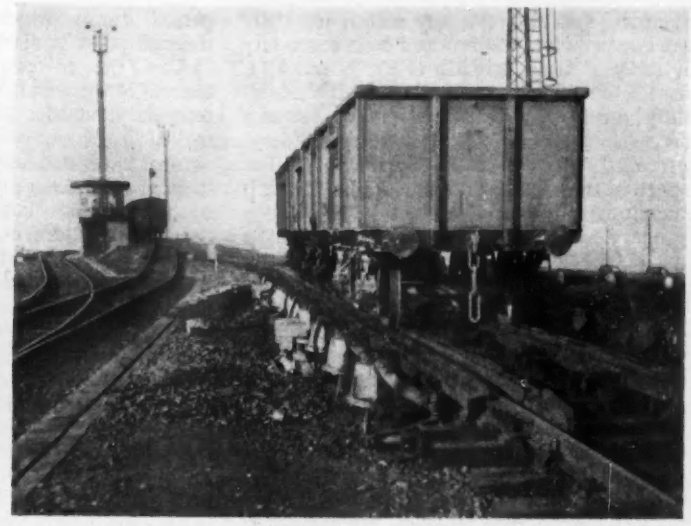


Fig. 7—Wagons being retarded on one of the primary retarders during shunting operations

To assist Temple Mills during the reconstruction period, other marshalling yards such as Whitemoor, Goodmayes, Thames Wharf, Mile End and Northumberland Park undertook additional segregations of traffic and certain trains were diverted there from Temple Mills. Here again the pattern constantly changed as the work progressed, but even during the most difficult stages, Temple Mills continued to deal with 80 per cent of its normal traffic, and throughout the period a remarkably high standard of transits was maintained. To achieve this so that the work proceeded to schedule entailed close co-operation between the various railway departments concerned, the contractors engaged upon the building and the yard staff, to ensure that no detail was overlooked and absolute safety maintained.

In order to accommodate the new yard layout it was necessary to resite the greater part of the Temple Mills wagon works. The main running lines between Stratford and Lea Bridge were diverted along the periphery of the yard and alterations were carried out at Lea Bridge station. It was also necessary to reconstruct completely Ruckholt Road overbridge and one span of the bridge carrying Lea Bridge Road. The footbridge at the site of Marsh Lane level crossing was replaced by a three-span " Usk " tubular steel footbridge about 320ft long. Initial work on the scheme also involved the reorganisation of the Commission's own electricity distribution network in the area, and new substations, connected to a high-voltage ring main system, have been established at the wagon shop and in the marshalling yard. The substation at the latter place is incorporated in the control tower building. This work involved the laying of 6400 yards of high-voltage underground cable, together with the installation of high-voltage and medium-voltage substation switchgear and transformers.

Hump Yard Working

The operation of a fully-mechanised hump marshalling yard divides itself into two clearly defined functions: the control of the speed of wagons, by the retarders; and the operation of the points to switch successive wagons so that they reach the correct sidings. It is taken for granted nowadays that the operation of the points must be by power, and initiated by the approach and passage of the wagons themselves through track circuit control. The intervals between successive wagons running down the hump are far too short, particularly at the King, Queen and Jack points, for an operator watching from the control tower to judge the time and distance. Clearly there must be close co-ordination between the operation of the points and the retarder controls, but in the past there has been a certain divergence of view as to the best method of achieving this co-ordination. In some early yards there were separate panels for the control of retarders and of the route setting, though both in the same control room in the tower, while later practice has tended to favour the use of a separate cabin at the crest of the hump, from which route setting is initiated, retaining the retarder controls in the main tower. In any event co-ordination is vital, so also is the means of conveying to the operator concerned the route of each " cut."

At Temple Mills there is a cabin at the crest of the hump, and this cabin is indeed the nerve centre of the sorting activities of the yard. The hump shunter has control of shunting of trains from the twelve reception sidings into the sorting sidings. He is responsible for setting up the routes that each successive " cut " in a train being humped shall take, and for light engine and hump engine movements in the immediate neighbourhood of the hump itself. On arrival in the reception sidings each train is scrutinised as to the destination of each wagon, or group of wagons forming a " cut." The siding number of each cut is chalked on the front of the leading wagon, and when the operation of humping begins, the hump shunter notes the routes required as each cut approaches the hump cabin and presses the appropriate route setting button on his track diagram. There are separate buttons for each of the sorting sidings, one for the transfer siding, and one for the brake van siding.

The system of point setting consists of a series of groups of storage banks of relays, for each pair of points. Each of these groups has a sufficient number of relays to store the maximum number of cuts that may be running between its points and the preceding points. Detailed reference to the method of operation will be made later, but it can be added here that throughout the area of automatic point working, the sequential working of the points is initiated by the passing of the wagons over track circuits which are normally de-energised. To distinguish these from the normal type of track circuits used in the signalling of passenger lines they are termed " rail circuits." They become energised as soon as a wagon enters the section concerned. At the hump cabin, as the shunter is not able to see enough numbers on wagons to use more than three at a time, provision has been made for a maximum storage of three routes. It is necessary to make special provision for certain wagons which cannot be dealt with by the normal automatic method of working. Occasionally, for example, there comes a wagon which for special reasons cannot be braked in the retarders, and occasionally there is a long wagon which cannot be relied upon to operate the route-setting. Separate buttons are included on the hump cabin control desk by means of which the control tower can be advised, and a pre-arranged routine for dealing with these special cases put into operation.

The hump cabin includes in its controls thumb switches on the panel for operation of the points and signals on the tracks immediately concerned, and also control of the hump signal. This latter is of a special kind, being a three-position upper-quadrant electro-pneumatically operated semaphore. When the arm is in the horizontal position it indicates " stop "; inclined upwards at 45 deg. it indicates " hump slow," and pointing vertically upwards it indicates " hump fast." The hump signal can also be controlled from the control tower. The operators in this latter building have a clear, elevated view over the sorting sidings and the groups of diverging points on the sorting sidings side of the hump, have to keep a general watch on the running of wagons, and it is essential for them to signal to the humping engineman to stop if the need should arise.

The working in the hump cabin is co-ordinated with that of Temple Mills West signalbox, which controls the entry to the yard from the main running lines. " Blocked" and " Clear " indications for each of the twelve reception sidings are provided in both cabins, and provision is made also for certain shunt signals, normally worked by Temple Mills West signalbox, to be operated by the hump cabin. Thumb switches are also provided on the panel for the release of points operated by Temple Mills West. Lamp indications are provided adjacent to these switches showing when the release has been operated and when it has been accepted by Temple Mills West.

Retarders

The retarders and associated equipment at Temple Mills have been supplied and installed by the Westinghouse Brake and Signal Company, Ltd., to the requirements of British Railways, Eastern Region. The system employs the electro-pneumatic type of

retarder, and as previously mentioned there are two primary retarders and eight secondary retarders. Each primary (Figs. 6 and 7) is associated with four retarders of the secondary group, and each secondary retarder serves a group of six classification sidings arranged on the balloon principle. The speed of the wagons passing over the hump is therefore reduced, if necessary, by both a primary and a secondary retarder *en route* to the classification sidings. The primary retarders have an overall length of 75ft and the secondaries 49ft. Two control desks, each equipped with retarder and point controls, are located in the control tower from which a clear view of both primary and secondary retarders is obtained.

The control tower is situated centrally, so that one primary and four secondary retarders lie on either side in symmetrical arrangement. The two primaries are equipped with automatic control which enables predetermined braking pressures to be applied, ready, before the wagons actually enter the retarders. This automatic control is extended over the period during which wagons are passing through the primary retarders and thus ensures the correct leaving speed. Final control of the wagon speed is effected by the secondary retarder which is manually controlled by thumb switches located on the control desk and arranged to give varying degrees of braking pressure at the discretion of the operator. The automatic control over the primary retarders is operated in response to wagon speed and weight measurements which are assessed during the interval time during the run in from the hump summit towards the primary retarders. The required information is computed electronically by the use of radar equipment together with information obtained from a weighing device installed as part of the permanent way. The retarders are powered by compressed air at a maximum pressure of 120 lb per square inch which is produced by three electrically-driven air compressors housed within the control tower building. Two of the compressors are selected as duty compressors at any one time whilst the third acts as standby.

(To be concluded)

Recent Thermonuclear Experiments with Sceptre IIIA

No. II—(*Concluded from page 725, May 8*)

In one of the papers discussed at the I.E.E. convention on thermonuclear processes (April 29–30), Dr. A. A. Ware gave some details of recent experiments with the toroidal discharge apparatus Sceptre IIIA (a modification of the earlier Sceptre III). The evidence of many of the measurements suggests that the large electron-energy loss associated with this type of discharge is caused by an electron-particle loss to the tube walls. If this is correct, the observed Doppler broadening and Doppler shift of the ion spectral lines have simple explanations. In the paper, reproduced (in part) below, a mechanism is suggested for the electron-particle loss.*

Theoretical Considerations

Ion Velocities and Ion Heating Mechanism.—The significance of the observed mean velocities of the highly ionised impurity ions has been studied.[13] If a simple model is taken for the discharge, in which instabilities are assumed to be absent, the mobility equations show that the deuterons should have a corresponding mean velocity which is somewhat greater than those of the carbon V and oxygen V ions. If this is the case the gas has a net momentum per unit length of discharge of about 1 dyne-second per centimetre. If no particle losses occurred from the discharge, the gas would have zero momentum and the mean positive-ion velocity would be only about 3×10^{3}cm per second, which is about three orders of magnitude less than the observed velocity. The results therefore suggest that negative momentum has been lost from the gas to the walls, and since the electrons possess negative momentum due to their drift velocity, the simplest explanation is that an electron-particle loss to the walls is the cause. During the quarter-cycle up to peak current the amount of momentum which the electrons receive from the electric field is about 50 dyne-second per centimetre, so the electrons need to lose 2 per cent of this momentum to explain the observed results.

Another significant feature of the high ion velocity is that the ions are carrying about 20 per cent of the gas current, and thus receive this fraction of the energy input direct from the electric field. The energy is converted to heat by particle collisions, and if the collisions with electrons are the main resistance to the deuteron drift velocity, most of the heat is received by the electrons, because of their low mass. If, however, collisions with impurity ions are more important, the deuterons will receive most of the heat, since the impurity ions are heavier than the deuterons. The latter is likely to be the case, since only a small percentage impurity of multiple ionised atoms is needed and the discharge spectra contain strong impurity lines, particularly of copper and aluminium.

If the deuterons retain the energy they receive from the electric field as heat, and if the main cooling process for the ions is by collisions with electrons, the steady-state deuteron temperature expected is of the same order of magnitude as that measured by the Doppler broadening.[13]

Electron Energy and Momentum Losses.—The evidence of the positive-ion mean velocities of the large electron current to the liners and of the X-rays suggests that the electron-energy loss is caused by an electron-particle loss mechanism. (Space-charge neutrality can be maintained by secondary-electron emission, arc-spot emission or by the ionisation of impurities emitted from the wall with the electrons entering the discharge and the ions passing back to the wall.) An upper limit for the mean energy of the electrons striking the wall can be obtained by the following simple argument.

If the momentum lost from unit length of the discharge is $-\mu$, then

$$-\mu=-\nu_e m\bar{v}_\phi+\nu_p\overline{M_pV_\phi} \quad . \quad . \quad . \quad (1)$$

where ν_e is the number of electrons lost to the wall per unit length of discharge, $\bar{v}_\phi$ is their mean velocity in the direction opposite to the current, ν_p is the number of positive ions lost to the walls, and $\overline{M_pV_\phi}$ their mean momentum in the positive direction. If the energy lost from unit length of the discharge is w, then

$$w=\tfrac{1}{2}\nu_e m\overline{v^2}+W \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where $\overline{v^2}$ is the r.m.s. velocity of the electrons lost to the wall and W is the energy lost by all mechanisms other than by the electron-particle loss.

From these two equations,

$$\frac{\overline{v^2}}{v_\phi}=\frac{2(w-W)}{\mu+\nu_p\overline{M_pV_p}} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Since the minimum value of W is zero, and if it is assumed that the minimum value of $\overline{M_pV_\phi}$ is zero (i.e. that the positive ions do not carry negative momentum to the walls), then

$$v<\frac{2v_\phi w}{v\mu}<\frac{2}{\mu}w \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Taking experimental results for the case V_c=25kV, $B_{\phi 0}$=0·5kG and $p=1\cdot4\times10^{-3}$ mm Hg, the energy lost by peak current per unit length was 6×10^{8} ergs per centimetre and a minimum value for the momentum lost was about 0·5 dyne-second per centimetre. Hence the maximum r.m.s. velocity of the electrons lost to the wall is $2\cdot4\times10^{9}$cm per second which corresponds to an energy of 2 keV.

The actual mean energy of the electrons escaping to the walls is probably well below this figure, since it is to be expected that $\bar{v}_\phi/v$ is considerably less than unity. Nevertheless, the limit is two orders of magnitude above the mean energy of the electrons in the discharge as indicated by the electron temperature, and the existence of an appreciable number of electrons in the discharge with energies well above the mean is confirmed by the X-rays observed. The most likely cause of these energetic electrons is the runaway process, since the conditions in the discharge, so far as they are known, are close to the threshold for this process to be significant.[14]

The Bars as the Electron-Loss Mechanism.—The evidence of the X-rays and of the large electron currents to the liners suggests that the electron loss may be concentrated on those points where magnetic lines of force pass from the discharge space into the tube wall. Once electrons have reached these particular lines of force, it is to be expected that they will be lost to the walls along the lines, since nothing except possible electric fields will impede their motion in this direction. It is necessary, however, to find a mechanism whereby electrons from the centre of the discharge can pass outwards and reach these lines of force. Classical diffusion and heat conduction across the magnetic field would both be too slow to explain the electron-energy loss.

If the density of the plasma in a bar is higher than in the plasma on either side in the ϕ-direction (the direction of the main gas current), the bars will furnish such a mechanism. Thus, away from the wall the radial component of electric field (E_r) should be negative. This field component, together with B_θ, will cause both electrons and ions to follow trochoidal paths in the

* A.E.I. Research Laboratories.

negative ϕ-direction. Owing to the larger Larmor radius of the ions and the effect of collisions, the resultant mean velocity in the negative ϕ-direction will be less for the ions than for the electrons. As a result, the excess ions and electrons in the bar will try to separate and the bar will become polarised with the positive charge on the side of greater ϕ. (The negative gradients of density and temperature in the radial direction also react with B_θ and produce polarisation of the same sign.) The space-charge field within the bar is in the reverse direction to the applied field, and this negative E_ϕ combined with B_θ causes the charged particles to drift radially outwards. The velocity will again be greater for the electrons. In this way any regions of higher density, such as the bars, will be effective funnels through which the electrons are encouraged to stream.

That a region of higher density should often take the form of an annular ring round the discharge is to be expected if B_θ is the main component of magnetic field in this region, since the excess density can spread unimpeded along the lines of force. The magnetic field will tend to prevent the excess density spreading in the ϕ-direction. If there is a B_ϕ component present, the higher-density region should take a helical shape along the lines of force. Such helical regions of luminosity are often observed on the streak photographs.

Conclusions

The experimental results suggest that the electron-energy loss mechanism is due to an electron-particle bombardment of the walls. On this basis the large drift velocities observed for the ions have a simple explanation in the negative momentum carried to the walls by the electrons. The large ion velocities in turn lead to a simple and consistent explanation of the Doppler broadening on the basis that it is due to a true thermal motion.

In addition, there is evidence that the electron loss is concentrated on those parts of the tube wall into which lines of magnetic force pass from the discharge space. A mechanism by which electrons can pass across the magnetic field and reach these particular lines of force is needed, and a simple argument shows that any region of higher density in the discharge will have a reversed component of electric field, E_ϕ, within it which will cause the electrons to drift outwards. The bars of light observed on all streak photographs may be such regions of higher density. If this is the case, the problem of the electron-energy loss reduces to the question : what is the cause of the bars ?

Acknowledgments

The author wishes to acknowledge that he is reporting the work of many colleagues, only a few of whose names have been mentioned in the text. Among those not mentioned, particular reference should be made to R. F. Hemmings, J. E. Read and G. A. Barnett, who have been responsible for the engineering of Sceptre III and IIIA, and to J. N. Barnet, who was responsible for the large power supplies used. The author is grateful to the Director of the Laboratory, Dr. T. E. Allibone, and to Sir George Thomson for their encouragement and many discussions, and again to the Director for permission to publish the paper.

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Design and Performance of "Zeta"

The proceedings of the I.E.E. convention on thermonuclear processes (held in conjunction with the British Nuclear Energy Conference) included a paper on the design and performance of "Zeta." The paper describes the main design parameters of the pinched-ring discharge apparatus "Zeta," the principal observations made with it during the period up to April, 1958, and the deductions on the physical phenomena occurring in the hot gas. Discharge pulses of up to 200kA have been passed through deuterium. The pinched current channel has a resistance of about 3 milliohms and an inductance of about 4μH. The power input corresponds to the magnetically confined gas losing its kinetic thermal energy every 100 microseconds. Energies of tracer impurity ions measured spectroscopically correspond to temperatures of 5×10^8 deg. K. Electron temperatures estimated from the resistance, microwave noise and spectroscopic intensities are in the range $1-5\times10^5$ deg. K. The greater temperature of the ions could be due to macroscopic gas motion. Abstracts from the paper follow.*

"ZETA" is an experimental apparatus for studying the pinched-ring discharge as a possible method of producing controlled thermonuclear power. The principle of this method is that the self-magnetic field of the discharge current isolates the plasma from the walls of the discharge tube.[1] An advantage of this method, particularly as regards experimental studies, is that the electromagnetic fields required to heat and contain the plasma can be provided both readily and efficiently ; an important obstacle is the inherent instability of a pinched current channel.[2] "Zeta" was designed to heat a plasma to about 10^8 deg. K, using a unidirectional current pulse lasting several milliseconds, since the maintenance of temperature for a relatively long time is an essential feature of a power-producing thermonuclear reactor.

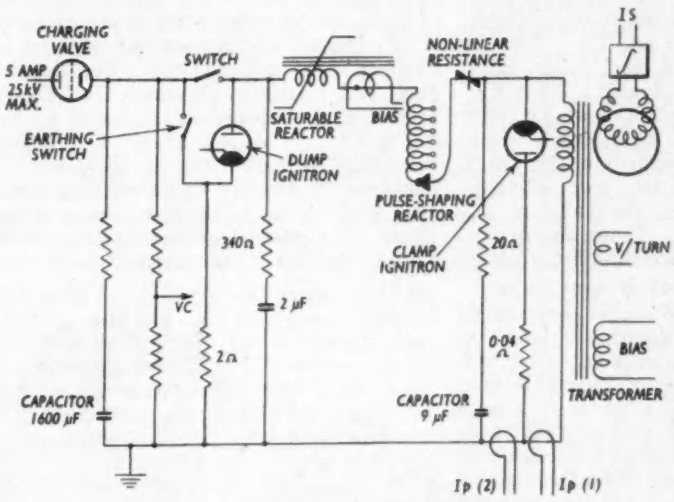


Fig. 1—Electrical circuit of "Zeta"

The thermal energy of the charged particles per unit length, $\frac{3}{2}NkT$, in a simple equilibrium pinched discharge is related to the current I by[3]

$$I^2=2NkT \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where N is the number of charged particles per unit length, k is Boltzmann's constant and T is the mean temperature. Experiments suggested that the minimum value of N for which a high-current discharge will form is about 10^{17} particles per centimetre. Consequently, currents of about 10^5A are necessary to attain a temperature of about 10^8 deg. K. The electric field and stored energy necessary to produce such current pulses could be predetermined only within wide limits ; the design parameters were therefore based on the most pessimistic assumption—that of a fully unstable discharge with a predominantly resistive impedance at a frequency of about 200 c/s. A large bore of tube was adopted to reduce this impedance, and is essential in a power-producing reactor to avoid excessive heat loading on the inner surface. It also minimises the ratio between the skin depth and the radial dimensions for a given pulse duration. To control instabilities, a metal torus was adopted and a toroidal coil was wound on it to generate a magnetic field, B_{zp}, parallel to the centre line of the discharge tube.

Preliminary observations[4] with "Zeta" and a detailed account[5] of experiments on the origin of the deuterium - deuterium reactions have been published. Details of the diagnostic techniques, studies of the nuclear reaction rates and of X-ray production are given in the paper by Harding *et al.*[6] The present paper reports the principal mechanical and electrical parameters, the performance as an electrical circuit, and our present knowledge of the physical characteristics of the plasma.

Electrical Design

The circuit is shown in Fig. 1. Energy is stored in the 1600μF capacitor bank, and the capacitors are discharged into the primary winding of the transformer by closing the switch, thus generating a gas discharge in the torus ; the transformer is iron-cored, in order to use the capacitors as efficiently as possible. The design was based on the requirement that the gas current should exceed 50kA for at least 3 milliseconds with a maximum resistive electromotive force of 2V per centimetre at current maximum. The bore of the torus was to be 1m.

To reduce the cost and volume of the capacitor bank, capacitors designed to operate with mainly unidirectional voltages were adopted, and the circuit elements were therefore designed to give critical damping. Under this circumstance, the current I is given by

$$I=\frac{Vt}{L}\exp\frac{-Rt}{2L} \quad . \quad . \quad . \quad . \quad (2)$$

* By Butt, Carruthers, Mitchell, Pease and Thonemann (U.K.A.E.A Atomic Energy Research Establishment) and Bird, Blears and Hartill (Metropolitan-Vickers Electrical Company, Ltd.).

with a peak value of

$$I_{max}=\frac{V}{\varepsilon}\sqrt{\frac{C}{L}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

occurring at a time

$$\tau=\sqrt{LC}=\tfrac{1}{2}CR \quad . \quad . \quad . \quad (4)$$

Here V is the capacitor voltage, L the circuit inductance, t the time and C the capacitance. The restriction of critical damping is relaxed when not operating at peak voltage, and also when the clamping circuit is in operation.

The Transformer.—The cross-section of the iron core threading the torus is determined by the product of the required electric field, E, at the centre of the torus and the time for which it is applied. Equations (1)–(4) give

$$\frac{D_1^2}{D_2}=1{\cdot}09\times10^9\tau\frac{E}{S\Delta B} \quad . \quad . \quad . \quad (5)$$

where

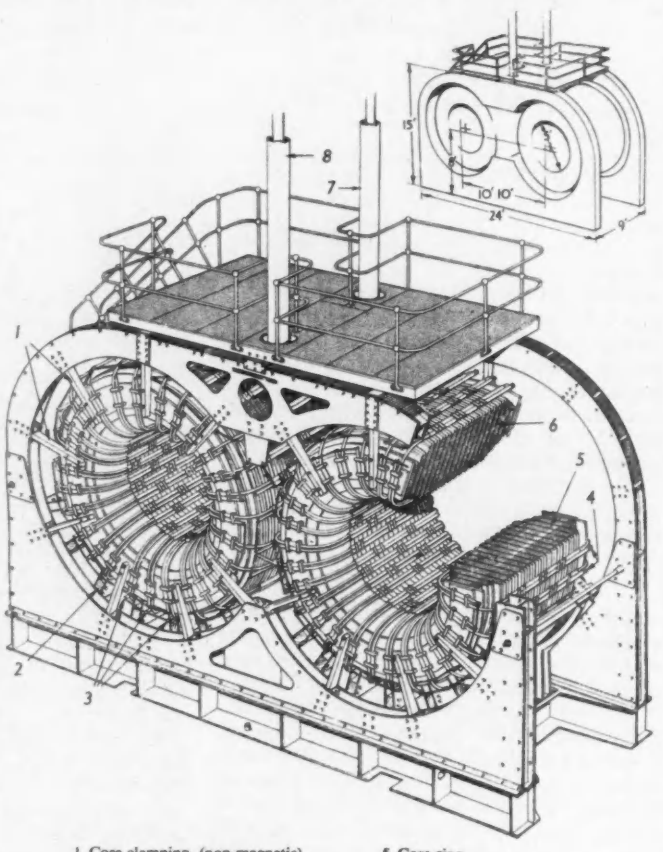
D_1=Diameter of the core, centimetres.
D_2=Mean torus diameter, centimetres.
τ=Pulse rise time, seconds.
E=Electric field at peak current, volts per centimetre.
S=Space factor of the transformer core.
ΔB=Maximum change of core induction, gauss.

To minimise the size of the core, and hence also the length and energy dissipation in the discharge, it is important to use material with the highest value of ΔB. This is obtained in cold-reduced steel, where ΔB= 32kG when the core is biased. With E= 2V per centimetre, S=0·6, τ=1·25 milliseconds (equivalent to 3 milliseconds width at half peak current), equation (5) yields D_1^2/D_2=140cm. Since the bore of torus requires $D_2=D_1+100$cm, the value of D_2 required is just over 2m. In the final design it was found possible to accommodate slightly more iron, and the core cross-section is 24,000 square centimetres, giving a core constant of 7V-sec per turn. The mean path length of the gas discharge is 1160cm.

The transformer (Fig. 2) is built up from ring units made by winding steel strips, 10cm×0·033cm, in the form of a clock spring with inner and outer diameters of 152cm and 304cm respectively. The units were annealed at 800 deg. Cent. after winding, and the interlaminar insulation is a magnesium-silicate film formed during annealing. Each unit has an inner supporting mandrel and an outer retaining band made from 9·5cm×0·63cm mild steel strip, the weight of each complete unit being just under 5 tons. These ring units are mounted in two adjacent groups of eighteen, forming two tunnels into which the torus is fitted, and are insulated from each other by phenolic sheet. The end units have modified diameters to accommodate the curvature of the torus. Each group of ring units carries fifty-four turns of rubber-covered cable with a copper cross-section of 0·65 square centimetres. Half of these turns are terminated individually on one face of the core, and are the main primary winding; the other half are terminated on the opposite face and are used to bias the core. These terminations allow the transformer ratio to be changed readily over the values 27, 13½, 9, 4½ and 3 to 1.

The core is biased to 15kG by a current of 400A in a three-turn winding supplied continuously from a metal rectifier. The pulse current, owing to the high voltage induced in the bias winding during the main pulse, is limited to a value equal to the direct bias current by a 54mH iron cored choke.

The Capacitors.—A study of the economics of capacitor manufacture and the working voltage of possible switches led to the adoption of 25kV as the operating potential. With a discharge path length of about 10m and an electric field of 2V per centimetre, the resistive electromotive force is 2kV per turn. In a critically damped circuit the peak resistive electromotive force =(2/ε) times the initial cacitor voltage. The best matching for maximum assumed discharge resistance is thus obtained with a turns ratio of 9 : 1. The design resistance of the discharge transformed to the primary is 1·6 ohms. The required capacitance is obtained from equation (4). For R=1·6 ohms and τ=1·25 milliseconds, C=1600μF, and when this capacitance is charged to the full 25kV, the energy stored is 0·5 MJ. Flexibility to match the actual discharge impedance is provided by the variable turns ratio and by the addition to the primary circuit of a pulse-shaping inductance with various tappings. The capacitor bank consists of fifty-two steel-tank units each of 31μF, each tank containing 1920 units of conventional mineral-oil-impregnated paper-and-foil construction. Internal fuses are provided for the isolation of any unit which becomes faulty. The capacitors are designed to withstand repeated voltage reversals, giving a peak-to-peak voltage swing of up to 25kV.



1 Core clamping (non-magnetic)
2 Core supports (non-magnetic)
3 Bias winding inter-turn connections
4 Pulse winding inter-turn connections
5 Core ring
6 Core ring unit insulation
7 Pulse supply busbars
8 Bias supply busbars

Fig. 2—Cut-away view of transformer

To limit possible fault currents should a capacitor break down or a short-circuit develop, a graphite-loaded ceramic-type 0·4-ohm resistor is connected in series with each unit. Each resistor is capable of absorbing the whole 0·5 MJ of stored energy.

The charging system is a d.c. supply fed through a transmitting-type valve with a water-cooled anode. This valve has a pure-tungsten filament and is operated to give temperature-limited current; this provides a much steadier current loading on the d.c. supply than can be obtained with resistance-limited charging. The grid potential of the valve is pulsed on and off, so that the valve also acts as a high-voltage isolator between the d.c. supply and the capacitors.

The Switch.—The capacitors are discharged into the transformer by a compressed-air-operated mechanical switch. To minimise electrical wear of the contacts, the switch was designed to have a short arcing time by using a double-break contact system, by giving a closing velocity of 600cm per second to the moving parts, and by filling the contact chamber with air at a pressure of 10 atmospheres. The switch is held closed by air pressure in the operating cylinder, and is opened either automatically after a short time delay or by a remote tripping circuit. The switch is not required to interrupt a large current, but the surge voltage due to breaking a current of a few amperes is limited by a 2μF capacitor and 390-ohm resistor in series across the circuit. The arcing time of this switch at 25kV is about 300 microseconds. To prevent the current rising to about 10kA before the contacts are firmly closed, a saturable reactor (magnetic switch) is used in series with the mechanical switch. This reactor was designed to limit the current to less than 100A for a hold-off time of 500 microseconds with an impressed voltage of 25kV, and to have a saturated inductance which was small compared with the total circuit inductance.

The parameters required for the design of a magnetic switch are L_s, the saturated inductance, t, the hold-off time, and V, the impressed voltage. If in the core and winding, ΔB is the flux swing to saturation, ΔH the m.m.f. change which results in ΔB and I the current in the winding at end of time t, i.e. the current producing ΔH, the following simple relations can be derived:

$$L_s=\frac{Vt\Delta H}{I\Delta B}$$

which can be written

$$I=\frac{Vt\Delta H}{L_s\Delta B}.$$

Volume of core required

$$=4\pi\times10^7\frac{V^2t^2}{(\Delta B)^2L_s}\ \text{cm}^3,$$

where V is in volts, t in seconds, L_s in henrys and ΔB in gauss.

The requirements were satisfied by a biased 2½-ton core of cold-reduced silicon steel. The saturable reactor has a saturated inductance of 70μH.

Circuit Protection Units.—The remaining components are chiefly to protect the capa-

citors from an oscillatory discharge, which could occur either under certain fault conditions or when the secondary resistance is much lower than that assumed in the design. The first such unit is the non-linear resistor, which has a high resistance at low currents. It was designed to limit the voltage reversal to 10 per cent when the secondary resistance falls to one-third of the critical damping value, and to reduce the normal peak current by less than 10 per cent. The resistor, made of discs of Metrosil, has a design characteristic given by $V=480I^{1/4}$V (I in amperes). The second unit is the clamping circuit designed specifically for a predominantly inductive secondary impedance. The circuit consists of two ignitrons, with 0·08-ohm load-sharing resistors, connected in parallel across the transformer primary. The ignitrons are triggered when the transformer voltage falls to zero, and are held conducting by the holding anode. The circuit traps most of the energy as inductive energy in the secondary circuit and extends the duration of the current pulse. Thirdly, the stored energy in the capacitors can be dissipated in a 2-ohm "dump" resistor. This can be connected manually, but is also connected by an ignitron which is triggered in the event of the gas discharge failing to strike. Without this protection the transformer core saturates, and a low, inductive impedance is presented to the capacitors when they are fully charged. Finally, there is an RC circuit across the transformer primary to protect the non-linear resistor and the switch from voltage transients generated in the gas discharge.

Torus Design

The torus was designed to meet the following basic requirements :

(*a*) It must be vacuum tight ;

(*b*) To achieve maximum-eddy-current stability and for maximum exclusion of stray magnetic fields, it must have the minimum number of electrical breaks ;

(*c*) Its body must not form a short-circuit, and the p.d's at the gaps in it must not lead to breakdown and the formation of power arcs.

The chief problem was thus the conflict between requirements (*b*) and (*c*). On the one hand, experiments in 35cm bores showed that, in the presence of a strong discharge, a single gap in hydrogen at 10^{-4}mm Hg broke down at about 100V; yet up to 2kV per turn was to be applied to the "Zeta" torus. On the other hand, experiments with a 35cm torus cut into several insulated sections revealed a significant decrease in eddy-current stabilisation and stray field exclusion. In the absence of ionisation, a single gap in hydrogen at 10^{-4}mm Hg was observed to hold off up to 4kV.

Torus Construction.—To meet requirement (*b*) the main torus body was made in two halves of 2·54cm thick aluminium, each half being mounted on a trolley for ease of assembly. The two main gaps where these halves join are inside the transformer tunnels ; electrical insulation here is provided by Bakelite and polythene gaskets, and the joints are made vacuum-tight by Neoprene gaskets. Each half was fabricated from short sections of rolled aluminium plate welded together. In the centre of each half there is a square window block containing ports and windows for observations, and the four main diffusion pumps are connected to the bottom of these blocks.

A liner system is mounted inside the torus to prevent ionisation from reaching the main gaps, which would otherwise break down. The liners are insulated from each other by a strip of polytetrafluoroethylene in tongue-and-groove joints, and are insulated from the main torus wall by nylon bushes. There are forty-eight liners giving a mean liner-to-liner potential of 40V at about 2kV per turn. The space between the liners and the main torus, which is about 3cm deep, is pumped by eight auxiliary diffusion pumps mounted outside the torus. A 0·6cm-core water-cooling pipe is welded into each liner to provide the main cooling system for the torus. The construction of the torus and liners is illustrated in Fig. 3.

Vacuum System.—The total volume to be

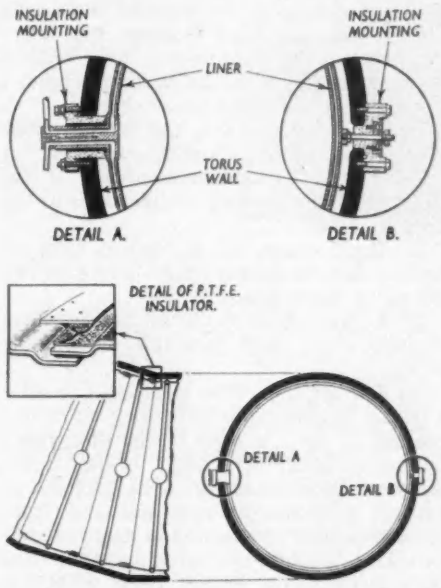


Fig. 3—Vertical and horizontal sections of "Zeta" torus and liner assembly

evacuated is about 12,000 litres, and the working pressure of deuterium between 10^{-4} and 10^{-5}mm Hg. The pumping system was designed to achieve a base pressure of 10^{-6}mm Hg in the presence of a leak rate of 3 litre-micron per second. This calls for a pumping speed of at least 3000 litres per second, which is achieved by using two 14in oil diffusion pumps on each half torus. Immediately above each pump is a refrigerated baffle (−15 deg. Cent.) and above this a large liquid-nitrogen-cooled trap with automatic level control. The torus-liner interspace is pumped by two 6in diffusion pumps mounted on each quadrant. All these pumps are backed by a rotary pump with gas-ballast facilities. Each half of the torus is self-contained, except for a common backing line, and can be built up and fully tested while withdrawn from the transformer. At the normal working deuterium pressure of $\frac{1}{8}\mu$ Hg, the pumping speed was measured to be about 6000 litres per second. The majority of the vacuum valves are electro-pneumatically operated, and protective circuits are used to shut the system down safely in the event of an excessive leak, or of pump or trap failure.

Hydrogen or deuterium is admitted to the system through heated nickel tubes to ensure high purity, the gas flow to the torus being controlled by adjustment of the nickel temperature ; other gases are admitted through a motor-driven needle valve. Pressures are measured on calibrated ion gauges, connected by short 2·5cm-diameter pipes to the window blocks, and are accurate to within 10 per cent. Leak detection is normally carried out with a helium mass-spectrometer leak detector ; in normal operating conditions it is necessary to clear the torus of deuterium by running discharges in some other gas, to avoid detecting D_2^+ ions in the spectrometer. The leak rate normally achieved is between 1 and 5 litre-microns per second. Because of the number (~300) of O-ring seals, it is not possible to bake the system, although heating to about 50 deg. Cent. was used on a number of occasions. The normal base pressure achieved was between 1 and 3×10^{-6}mm Hg.

Both spectroscopic observations and mass-spectrometer analysis of samples of gas indicate that the proportion of impurities present during the discharge is not, in general, given by the simple ratio between the base and working pressures, because impurities removed from the walls play a major role. The number of atomic sites on the walls is about 10^{18} per centimetre of discharge, so that if 10 per cent of a monatomic layer is released into the discharge, the amount of impurities is equal to the amount of deuterium at normal operating pressure ($N\simeq10^{17}$ particles per centimetre). A striking feature of the apparatus is the clean-up which appears to take place during running.

Axial Magnetic Field.—The axial magnetic field is supplied by fifty fifteen-turn coils mounted between adjacent liner mountings with auxiliary windings added at the window blocks and main gaps to give improved uniformity of the field. The coil is wound from a flexible cable of 1·3 square centimetre copper cross-section covered with varnished "Terylene," and is suitable for continuous operation at currents up to 200A (B_{z0}= 160 gauss). For higher magnetic fields the current is pulsed in synchronism with the main discharge pulse. Owing to the time taken for flux to penetrate the torus wall, a current pulse duration of about one second is necessary. Supplies are available to provide up to 1kA at 1kV.

Ionisation of the Gas.—The applied pulsed electric field is insufficient to cause a breakdown in hydrogen at a pressure of 10^{-4}mm Hg. The gas is therefore ionised by producing a radio-frequency glow discharge inside the torus. A 3 Mc/s oscillator is connected capacitively to two of the liners, giving an r.f. current of a few amperes, but is suppressed during the main current pulse to reduce interference in the various measuring circuits.

Control and Instrumentation

The equipment for controlling,[7] monitoring and recording the discharges is centralised in the control room. The main units here are : (*a*) a control desk, on which are mounted the chief manual controls, the timer, safety switches and monitoring oscillographs ; (*b*) an eight-channel recording oscillograph, on which selected transients from each discharge are photographed ; (*c*) racks containing apparatus for controlling the stabilising magnetic field, the bias supplies, the ionising r.f. discharge, pressure gauges and fault-monitoring equipment.

Cyclic Operation.—The detailed switching sequence of the main discharge circuit is operated by a rotating drum-timer. The drum rotates once every twelve seconds (ten seconds in early experiments) and the operation of nine separate circuits can be adjusted to within 0·1 second. The chief units switched from here are the charging-circuit valve, the pulsed axial field and the mechanical switch. One of the circuits ensures that a complete cycle is always finished ; other circuits are used for operating such auxiliary items as discharge-number registers and camera shutters. By means of the drum timing, "Zeta" can be operated

for many hours with only minor adjustments to the manual controls of gas pressure, axial field and condenser voltage. Operation ceases automatically under various fault conditions. Single-shot operation can also be carried out.

Electronic pulses for operating equipment during the discharge are provided by a ten-channel pulse generator. Each channel has a separate delay circuit for presetting the time of the pulse to within about 5 per cent up to a total delay of 10 milliseconds. The generator is started by pulses derived from voltages in the primary circuit of the transformer. These timing pulses operate oscillograph time-bases, the r.f. suppressor, the " dump " circuit, and experimental equipment such as image convertors and gating circuits for counting equipment.

Monitoring and Measuring Equipment.—In such a high-power circuit as " Zeta " it is most desirable that the operator should be able to observe readily and reliably any unusual behaviour of the circuit before damage occurs. This requirement has been met by installing two Memotron storage-type cathode-ray tubes,[8] which retain the transients until they are deliberately erased. Any two of the eight transients being recorded on the eight-beam oscillograph can be selected for presentation on the Memotron tubes. The timing and sensitivity of the recording oscillograph and the Memotrons is calibrated by standard pulses fed from a stabilised generator. The timing of these pulses is derived from a quartz oscillator, and the amplitude is determined by a gas-filled voltage-reference tube.

The normal information fed into the eight-channel recording and monitoring system includes :

(*a*) Capacitor voltage, measured by a resistance potential-divider.

(*b*) Primary-circuit current, measured by current transformers placed both outside and within the clamping circuit.

(*c*) Secondary current, measured by integrating the potential given by a Rogowski coil placed round the discharge tube (Rogowski coils within the tube have also been used).

(*d*) Voltage per turn, measured by a single turn around the transformer core and a resistance potential-divider.

A large number of further signals derived from equipment such as neutron counters and spectroscopes can be fed into the eight-channel system. To reduce interference from the electromagnetic field set up by the discharge, separate earth connections are provided for light-current and heavy-current circuits, and balanced twin cables and balanced input circuits are used on the oscillographs.

Operational Experience

After preliminary circuit tests using a stainless steel loop as the secondary, " Zeta " was first operated on August 12, 1957. The early experiments, carried out in hydrogen at low currents, served to check details of the circuit and instrumentation. In the next stage, conditions were found for which a heavy-current discharge of interest to thermonuclear plasma studies could be obtained repeatably. In particular, neutrons from $D(d, n)$ reactions were detected. The essential feature of such conditions is that the initial value, B_{z0}, of the stabilising field should be about 150 gauss, depending on the discharge current. The stabilising field for optimum neutron yield increases with current, and it appears that, if the plasma traps all the B_{z0} flux, the pinch effect cannot produce a calculated enhancement of the initial flux density of more than twenty times. With larger fields the nuclear reaction rate decreases ; with smaller fields there are many signs of serious instability, notably high resistance and widely fluctuating magnetic fields in the discharge. This is in accord with the stability criterion of Tayler.[9]

" Zeta " has been operated for about six months, mostly under a limited range of conditions ; deuterium pressure of $\frac{1}{3}\mu$Hg, initial stabilising field (B_{z0}) of 160 gauss, and currents in the range 140–180kA, obtained with a 9 : 1 turns ratio. For most of the experiments the pulse-shaping reactor was short-circuited. Operation of the machine with heavy currents was limited to avoid excessive damage to the liner system. After prolonged running at currents exceeding 160kA, the insulation between the liners deteriorated and liner-to-liner arcs became frequent, leading to insulation failures requiring a lengthy and expensive overhaul.

Between August, 1957, and March, 1958, there were about 150,000 discharges in " Zeta," and four major overhauls of the liner system. The chief modifications to the apparatus were :

(*a*) Replacement of an earlier form of liner-to-liner insulation (glass fibre tape) by the p.t.f.e. insulation.

(*b*) Improvements to the uniformity of the B_{z0} field at the main gaps and the window blocks.

(*c*) The addition of the clamping circuit.

These modifications produced no major changes in the character of the discharge ; indeed, a feature of " Zeta " is the consistency of performance in such respects as neutron yield and discharge resistance from run to run, after overhauls and minor modification. Long periods of cyclic operation have been possible, the longest being 3500 discharges in ten hours.

In this initial operating period the reliability of the major components of the electrical circuit was satisfactory. Most trouble was experienced with relatively standard items, such as air-control valves in the main switch failing after long periods of repetitive operation. Failures of the clamping ignitrons to hold off the main voltage have occurred, probably due to the absence of temperature control on the ignitrons. It has been our experience that the reduction of interference in control and instrumentation circuits is of the greatest importance for trouble-free operation and experimentation.

Conclusions

X-rays of 20keV and upwards and deuterium-deuterium reactions due to non-thermal processes have been observed. If these processes are a result of runaway particles, they account for only a fraction of the total current, i.e. 25A of runaway electrons and 1A of 17keV deuterons.[5, 6]

Both inductance and magnetic-search-coil measurements show that the current channel is constricted into the centre of the discharge tube, and the stabilising field is enhanced by a factor of about ten. The stabilising field is not trapped by currents flowing only on the surface of the plasma, and the observed distribution of magnetic fields has yet to be explained.

At peak currents of 140–180kA the resistance of the discharge and the fluctuations of the magnetic field increase markedly as the stabilising field is reduced from about 160 gauss. At very low fields the discharge often fails to strike in clean conditions.

Streak pictures taken with the normal stabilising field indicate that the plasma is isolated from the walls for periods of up to 1 millisecond in nitrogen and in contaminated helium and deuterium. Under clean conditions the magnetic-field fluctuations and the current and voltage transients suggest that the plasma is by no means stationary.

Impurity ions in the channel have been observed spectroscopically to have energies up to 500eV. These energies, which are much larger than the mean electron energy, may be accounted for by this motion of the plasma, both directly and as an ion-heating mechanism.

The observed power input and the estimated maximum plasma energy ($\frac{1}{2}NkT$) suggest that the energy containment time, Δt_2, cannot exceed about 100 microseconds. The efficiency of " Zeta " as a thermonuclear reactor is indicated by the Lawson product, $n_i \Delta t_2$, which is thus about 10^{10} second-ion per cubic centimetre. This may be compared with the value of 10^{16} second-ion per cubic centimetre required for a power-producing thermonuclear reactor (deuterium-deuterium).

" Zeta " is capable of considerable further development. Ultimate restrictions imposed by heat loading of the walls and the available flux swing in the transformer core have not yet been approached. Currents of about 1MA should be obtainable by increasing the capacitor bank. The limiting factor in the experiments described herein has been the insulation of the liner system.

" Zeta " has fulfilled its planned function of producing a hot plasma for experimental studies of the possibility of a thermonuclear reactor based on the pinched gas discharge. It is clear that a very wide range of physical phenomena occur in the discharge and that many further experimental and theoretical studies are necessary before it is possible to make reliable predictions about a power-producing thermonuclear reactor based on this principle.

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British Standards Institution

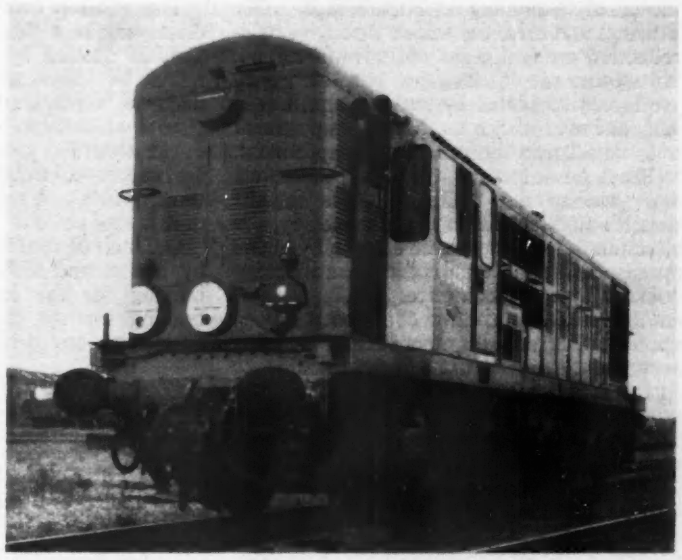
All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

ROUND COPPER CONDUCTOR WIRE : METRIC UNITS

Four new specifications have been published for covered winding wires in metric units, as follows : B.S. 1815 : 1959, " Enamelled and cotton-covered copper conductors " (price 4s. 6d.) ; B.S. 1933 : 1959, " Varnish-bonded glass-covered copper conductors " (price 4s. 6d.) ; B.S. 2479 : 1959, " Enamelled and silk-covered or rayon-covered copper conductors (oleo resinous enamel) (price 5s.) ; B.S. 2480 : 1959, " Silk-covered and rayon-covered copper conductors " (price 5s.). The three previously existing standards in metric units are B.S. 1961, B.S. 2039 and B.S. 2084, dealing respectively with wires covered with oloe-resinous enamel, vinyl acetal enamel and cotton. The requirements of all these standards are essentially the same as those of the corresponding standards in British units, but metric measure is used throughout and a complete range of standard metric sizes is given. For convenience, each of these new standards is published as Part 3 of the corresponding standard in British units.

Diesel-Electric Locomotives for Mixed Traffic

The most recent additions to the Type 2 (1000/1250 h.p.) diesel-electric locomotives ordered under the British Railways modernisation programme of 1955 are the 6100 series now entering service on the Great Northern Line. The electrical transmission is generally similar to that of the Type 1 locomotives by the same builders (one of which is illustrated alongside) but the two classes have different makes of diesel engine. Both have the B_0-B_0 wheel arrangement.



IN 1951 the first diesel-electric locomotives built by the North British Locomotive Company, Ltd., with electrical equipment by The General Electric Company, Ltd., were delivered to the Ceylon Government Railway, consisting of eight B_0-B_0 shunters of 625 h.p. The same two builders received orders for two series of locomotives under the British Railways pilot diesel scheme of 1955, one being for ten 800 h.p. locomotives (Type 1) and the second for ten locomotives of 1000 h.p. (Type 2). Subsequently the Type 2 orders were increased by twenty-eight, and in these later locomotives the diesel engines will be set at 1100 h.p.

As seen in the heading illustration, the N.B.L.-G.E.C. Type 1 B_0-B_0 locomotive is of the single-cab design with bonnet superstructure now generally adopted by British Railways for freight transfer work and light passenger duties (where train heating is not required, there being no boiler for this purpose). The engine is the Paxman 16YHXL. Maximum tractive effort of the locomotive is 42,000 lb, continuous rated tractive effort 20,000 lb, and maximum speed 60 m.p.h. The locomotive weighs 68 tons in working order.

Fig. 1 shows the Type 2 locomotive. This is a double-cab design suitable for a range of duties including passenger working, train heating being provided by a Spanner boiler and the maximum service speed being 75 m.p.h. The engine is the N.B.L.-M.A.N. "L12V 18/21S" twelve-cylinder vee pressure-charged four stroke, rated at 1100 b.h.p. at 1500 r.p.m. This is the same engine as used in the North British 2000 h.p. "Warship" class locomotives of the Western Region, described in our February 28, 1958, issue, page 327, and is also being installed in the diesel-electric Pullman trains with N.B.L.-G.E.C. main power equipment now being built by the Metropolitan-Cammell Carriage and Wagon Company, Ltd., for the Western and London Midland Regions.

The Type 2 locomotives have an all-welded underframe and an all-aluminium superstructure in which the body sides, sectional roof and bulkheads are built up of extruded aluminium channels and I-sections, forming a framework to which the aluminium skin is riveted. The four-wheel, swing-bolster bogies incorporate one-piece cast steel frames supplied by the English Steel Castings Corporation, Ltd. The bolster is supported by laminated springs carried on a plank suspended by swing links from the bogie frame, and the load is transferred from the frame to the Skefko roller bearing axleboxes by equalising beams and four nests of coil springs. Some dimensions and other details of the locomotive are tabulated below.

Maximum tractive effort	45,000 lb
Continuous rated tractive effort ...	25,000 lb at 1000 h.p. at 11 m.p.h. ; 30,000 lb at 1100 h.p. at 10 m.p.h.
Weight in working order	72·5 tons
Minimum curve	4½ chains
Fuel oil capacity (engine and boiler)	460 gal.
Boiler water capacity (tank capacity for 600 gal.)...	480 gal.
Length over buffers	51ft 6in
Bogie wheelbase	8ft 6in
Bogie pivot centres	28ft 6in
Wheel diameter	3ft 7in

Whereas the radiator fan in the Type 1 locomotives is driven from the engine through a right-angle gearbox, in the Type 2 it is operated at variable speed according to the coolant temperature by a Serck/Behr hydrostatic drive consisting of an engine-driven hydraulic pump delivering oil through a thermostat-controlled by-pass valve to a hydraulic motor. The Serck radiator is a built-up structure providing a central tunnel-shaped passage with side ducts housing the cooling elements.

Electrical Equipment

The G.E.C. generator sets of the Type 1 and Type 2 locomotives are similar in construction, consisting of a main generator with the driven end of its armature shaft bolted by a coupling flange to a corresponding flange on the engine crankshaft, and the commutator end carried in a self-aligning parallel roller bearing in the end shield. An extension of the armature shaft carries the overhung auxiliary generator, which is flange-mounted on the main generator. The main generator frame is supported on an extension of the engine bedplate and the whole unit is mounted on four Metalastik resilient mountings.

In both locomotives the main generator is a six-pole, self-ventilated machine. The Type 2 generator has a continuous rating of 1700A, 375V at 1500 r.p.m., and a maximum voltage of 635 for the ten locomotives of 1000 h.p. For the 1100 h.p. locomotives it will be uprated continuously to 1940A, 367V at 1500 r.p.m., and a maximum voltage of 620V. The auxiliary generator has an output of 35kW and is regulated at 110V by a Newton carbon pile regulator.

Traction motor ratings for the locomotives of 1000 h.p. are 425A, 375V, 189 rail h.p

Fig. 1—The first of thirty-eight 1000/1100 h.p. locomotives for the Eastern Region, British Railways

at 372 r.p.m. Later locomotives of 1100 h.p. will have their traction motors uprated to 485A, 367V, 207 rail h.p. at 350 r.p.m. The motors are axle-hung on Timken taper roller bearings and drive the wheels through single-reduction resilient gears with a ratio 15 : 64. All motors are connected in parallel. They are forced-ventilated by two 7·6 h.p. blower sets, one mounted in the boiler compartment and the other in the generator compartment.

The first ten locomotives of Types 1 and 2 were among the "pilot" orders for the diesel scheme, and are controlled by the selection of predetermined diesel engine speeds, as in the Brush and Metropolitan-Vickers Type 2 locomotives. Other designs in the programme have continuous engine speed control, and this practice is now tending to predominate, so that a review of practice in the interests of unrestricted multiple-unit working would seem possible in perpetuating the basic "pilot" designs. In the G.E.C. system the engine runs at idling speed on the first three notches, of which notches one and two provide two degrees of main generator separate excitation by means of a fixed resistance, while on notch three the automatic load regulator comes into operation by

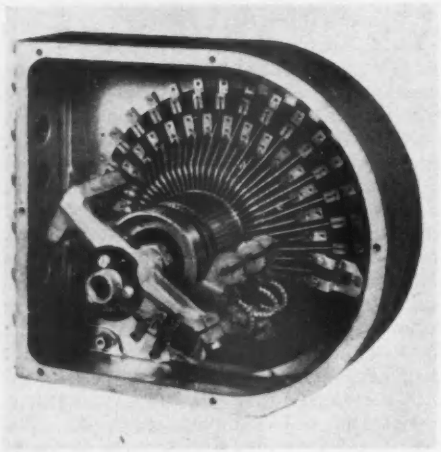


Fig. 2—Oil servo-regulator for the second series of Type 2 locomotives, showing the fixed commutator, to the segments of which the regulating resistance sections are connected, and rotating brushgear

energisation of two hydraulic/electric valves. While these valves are de-energised, the regulator is moved towards its minimum excitation position, but when operated they allow the hydraulic motor of the load regulator to drive brushes round a stationary commutator, the segments of which are connected to the regulating resistance. The hydraulic supply is from the engine lubricating system and is regulated by a control valve actuated by the engine governor. Fig. 2 shows the commutator segments and rotating brushes of the load regulator to be fitted in the later series of Type 2 locomotives. The same principle of operation was first used in the N.B.L.-G.E.C. locomotives for the Ceylon Government Railway mentioned earlier.

On notches four to ten the engine speed and power are increased in predetermined steps. Fie'd-weakening of the traction motors may be introduced automatically in the appropriate conditions of current and voltage at all engine speeds, being initiated by a relay in the generator field circuit. When this operates, the electro-hydraulic valves in the load regulator system cause the generator excitation to be reduced, and the weak-field contactors may then close. Three steps are available by field diversion and follow automatically as appropriate. As each step is taken, the load regulator is restored to normal operation. Notching back to full field also takes place automatically under the control of a current relay in one motor circuit.

The anti-slip control acts directly on the diesel engine, returning it to idling speed. This is effected by causing the wheel slip relays to de-energise the three electro-magnetic valves controlling the oil-operated pistons which set the engine speed. Resetting of the wheel slip protection takes place when the master controller is returned to notch three, after which the driver is in full control of restoring power.

Oerlikon pattern brake equipment supplied by Davies and Metcalfe, Ltd., provides air braking for the locomotive and vacuum braking for the train. The two Reavell exhausters are driven by G.E.C. motors arranged to run at a maintaining speed of 715 r.p.m. or a release speed of 1430 r.p.m. by means of field divert resistances.

These Type 2 locomotives will be employed mainly on Great Northern Line inner and outer suburban services such as King's Cross—Hertford and King's Cross—Hitchin. They were designed, and are being constructed, to the general requirements of the British Transport Commission under the overall direction of the Chief Mechanical Engineer and Chief Electrical Engineer, British Railways Central Staff, British Transport Commission, the Chief Mechanical and Electrical Engineer, Eastern and North Eastern Regions, being responsible for liaison with the contractors, and for inspection during construction and preliminary testing.

Steel Plates for Pressure Vessels

In his presidential address to the Iron and Steel Institute, on May 6, Mr. W. Barr commented on progress in the development and application of steel plates. He reviewed various factors which had influenced development and indicated some general trends in plate requirements. This extract from Mr. Barr's address deals with plates for pressure vessels.

PLATES used in pressure vessels are made to a standard known as "boiler quality," because of their traditional use in the manufacture of steam boilers where, for reasons of safety, a higher and more uniform standard was required than for ship-quality plates. The quality of such plates is controlled by specifications which call for acceptance tests from each rolled plate. At one time most of the boiler plates in this country were made from acid open-hearth steel, but over the last twenty years or so, owing to improved production techniques, the great proportion of the plates are made from basic open-hearth steel, which is capable of meeting all demands.

Here again the introduction of welding in the fabricating shops has had its effect in a gradual upgrading of steel quality to meet the stringent demands imposed by the inspecting authorities. Because of the practice of stress relieving, notch ductility is not a major problem, and no British specifications for plates for use in pressure vessels make reference to this factor except for service at sub-zero temperatures. In many Continental countries, where steels produced by processes other than the open-hearth process were permitted for pressure vessel construction, specifications for pressure vessel steels include a notch ductility clause for boiler shell plates. For commercial reasons, therefore, this factor should be borne in mind when revising our relevant specifications, since it may have a considerable influence on our steel exports. To the fabricator, welding as opposed to riveting has made it possible to meet demands for more economic power production by increasing operating pressures and temperatures. Progress in this direction has proceeded apace, with progressive increases in the thickness and dimensions of plates. This, in turn, has led to a demand for higher-tensile steels.

The best quality of steel for welded pressure vessels is silicon-killed cast in wide-end-up ingot moulds with hot tops. For plates of reasonable dimensions at 5in thick, an individual plate may weigh as much as 20 tons, being rolled from a 35-ton ingot. That is to say, the ingot-to-plate yield is only 60 per cent. However, even with this practice, a major problem arises from the variation in chemical composition, and particularly the variation in the carbon content from the bottom to the top of such large ingots; the higher the carbon content of the steel, the greater the problem in this respect. For this reason there is a limit to the tensile strength that can be achieved in such heavy plates in a straight carbon–manganese steel without risk of welding troubles due to local concentrations of carbon at the central axis of the plate adjacent to the top discard. Such difficulties can be minimised by the use of a low-alloy steel with a low carbon content, so that the segregation of this element is reduced. In theory there are many ways in which one can ring the changes in the choice of alloys for steels of this type, but in practice the final choice must inevitably be influenced by costs so that the product may be economically attractive to the user.

The problem has been tackled in various ways, and there have been several interesting developments, but I propose to confine my remarks to one particular steel, in the development and application of which I have first-hand knowledge, and which, like other steels of this type, is characterised by relatively high ratio of yield stress to ultimate tensile strength. My object here is to illustrate from a practical example how certain aspects of our design code prevent the application of these steels in as economic a manner as is possible in certain Continental countries. This refers particularly to the use of the steels in the medium temperature range as in steam boiler drums. This proprietary steel, which contains a particular combination of manganese, chromium, molybdenum, and vanadium, is being produced regularly in large tonnages in the form of plates up to 5½in thick and is giving satisfactory service in some of the largest welded steam drums in modern high-pressure power stations in this country. The guaranteed minimum tensile for plates within the thickness range 3in–6in is 36 tons per square inch, which is the relevant factor

for design purposes according to current British practice. The salient features of the steel are given in Tables I–III.

TABLE I—*Manganese–Chromium–Molybdenum–Vanadium Steel*

Chemical analysis	Specification, percentage maximum	Target, percentage
Carbon	0·17	0·15
Silicon	0·30	0·15
Sulphur	0·05	—
Phosphorus	0·05	—
Manganese	1·50	1·3
Chromium	0·70	0·50
Molybdenum	0·28	0·26
Vanadium	0·10	0·08

TABLE II—*Specified Temperature Proof Stress Data*

Thickness	0·2 per cent proof stress, tons per square inch minimum								
	20 deg. Cent.	100 deg. Cent.	200 deg. Cent.	250 deg. Cent.	300 deg. Cent.	350 deg. Cent.	400 deg. Cent.	425 deg. Cent.	450 deg. Cent.
Up to 1in	30	29	27	26	25	24	23	21	19
Above 1in up to 3in	27	26	25	24	23	22	21	19	17
Above 3in up to 6in	24	23	22	21	20	19	18	17	15

TABLE III—*Typical High-Temperature Tensile Data 5in Thick Plate Normalised From 900 Deg. Cent., Tempered For Two Hours at 650 Deg. Cent.*

Plate analysis percentage	C	Si	S	P	Mn	Cr	Mo	V
	0·15	0·13	0·030	0·020	1·32	0·65	0·23	0·07

Testing temperature, deg. Cent.	0·2 per cent proof stress, tons per quare inch	UTS, tons per square inch	Elongation percentage, $4\sqrt{A}$
20	29	38	26
200	25	35	24
300	22	36	25
350	24	38	22
400	20	34	23

The design stresses employed in this country for both ordinary carbon steels and special steels of the type mentioned above are substantially lower than the stresses used for similar steels in many other countries. Apart from the effect on the cost of construction of vessels for use in this country, the situation is having adverse repercussions on our exports. The extent of our handicap in this respect is shown by the difference in design stresses permitted for the above steel according to British and Continental codes of practice. For a service temperature of 350 deg. Cent. (660 deg. Fah.), the British Standard B.S. 1500 stipulates that the design stress shall be one-quarter of the ultimate tensile strength at ambient temperature. The Continental code, on the other hand, stipulates that the design stress shall be two-thirds of the 0·2 per cent proof stress at the service temperature, provided that this does not exceed 75 per cent of the ultimate tensile strength. The design stress for this steel under these conditions is 8½ tons per square inch following the British code, compared with 14 tons per square inch following the Continental code. It will be appreciated that the acceptance of the proof stress instead of the ultimate tensile strength as a basis for design in the intermediate temperature range reacts most unfavourably in the case of the low-alloy steels of the type described.

An example of what this means in practice may be quoted. On a recent occasion, this steel was used for the manufacture in this country of a welded vessel designed for a pressure of 2060 lb per square inch and an operating temperature of 340 deg. Cent. (644 deg. Fah.). The vessel was intended for export to a Continental country and design was based on the 0·2 per cent proof stress at the operating temperature, the data for which were made available by the steelmaker (see Table III). The result was a vessel, the shell plates of which were 2½in thick, but the same vessel used for the same purpose in this country would have required the thickness of the plates to have been increased to 3½in. After the vessel had been manufactured and despatched, the Continental authority, while accepting the basis of design, found itself in some difficulty because there existed no standard specification in the country of origin of the material which imposed any control on the proof stress at the service temperature. Eventually it was agreed to treat the certification of the vessel as a "special case," and it was ultimately accepted following the satisfactory completion of additional proof stress tests.

This case illustrates the difficulties that beset British manufacturers tendering for plant of this nature to the many countries which accept Continental practice. If British industry is to compete on anything like even terms with foreign manufacturers in world markets, it is evident that advantage must be taken, in suitable cases, of the superior intermediate temperature properties of low-alloy steels and British Standard Specifications making reference to 0·2 per cent proof stress data for such steels are urgently required. If we are to maintain our competitive position, it is desirable that we make the most effective use of carbon and alloy steels compatible with adequate safety. It is necessary to consider, therefore, the factors that limit the design stress adopted by a British firm producing vessels for both the home and export markets. Considering first the position with regard to vessels produced for the home market, even if the fabricator is satisfied that he could safely increase the design stress above the figure recommended in the appropriate British Standard, he cannot do so without the approval of a competent inspecting authority. It is generally true to say that none of the British inspecting authorities is prepared to approve any design procedure which would involve the use of design stresses higher than those stated in the appropriate British Standard. As a consequence of this policy, an alteration in design procedure that would result in an increase in the stress on the steel can only be brought about by amendment of the appropriate British Standard Specification.

A British Standard Specification, at least in so far as it concerns pressure vessels and boilers, is the result of a compromise between the engineering insurance companies' views and the manufacturers' views. Standards are not amended to cover improved procedure until use in service has shown that the procedure is satisfactory. Thus, it is usually the case that where service conditions demand a type of construction outside the range covered by an existing British Standard, agreement has to be obtained between the purchaser and the manufacturer on the features of design or methods of manufacture which are departures from standard practice. In the sections of engineering to which reference has just been made, it is fortunate that British manufacturers do considerable business abroad, where they are able to obtain evidence of the satisfactory performance of advanced designs and are able to use this evidence in arguing their case for modification to existing British Standards.

Engineering insurance companies in Britain are the people who decide the insurance premium to be paid on any new plant and, because of the vague wording of the Factories Act, 1937, their engineers are normally regarded as the persons competent under the Act to certify a pressure vessel for service under the conditions for which it was installed. There are very few legal regulations in the United Kingdom relating to the design of pressure equipment of the class under discussion, and so it has become customary for specifications such as B.S. 1500 and B.S. 1113 to be used as a criterion upon which the fulfilment of the Act is determined. A consequence of the above procedure is that progress in development of design procedure for vessels is very slow. In the early part of the century, the procedure proved satisfactory in that technological progress was also slow and the standard design practice never fell too far behind the most advanced practice employed elsewhere in the world. However, nowadays technological development proceeds at a more rapid pace and the operation of this procedure for amending British practice has resulted in the standards falling behind the most economic modern practice as represented by anumber of foreign codes.

As far as the export trade is concerned, British manufacturers may, and in fact do, quote on the basis of the regulations existing in the country where the plant is to be installed, provided, of course, they are satisfied that the resulting product is in keeping with the standard of quality which they desire to uphold as a company. British industry can, however, be placed at a disadvantage if the requirements with which they have to comply in the United Kingdom result in the installation of manufacturing plant in their works which requires capital expenditure greatly in excess of that necessary for the manufacture of lighter equipment acceptable abroad. It is also true to say that a programme of steel development that would best meet requirements in the United Kingdom may be less suitable as a means of serving trade abroad. It could possibly be claimed that the steelmaker would have to go to the expense of running two separate development programmes, one for home demand and one for export, which it must be admitted is an unsatisfactory state of affairs. There is little doubt that lack of authoritative data on the properties of both standard steels and proprietary steels in this country has adversely influenced the engineering insurance companies, and other survey bodies, in considering proposals for increased stresses. It is notable that certain Continental steel manufacturers have done better in this respect, and have been rewarded by the adoption in their country of more enlightened ideas by the authorities responsible for boiler regulations and the like. Nevertheless, the steelmaker must know what class of data is going to be required, as it is wasteful and useless to produce unnecessary information. This being the case, those responsible for design should, first of all, determine in principle the basis upon which permissible stresses are to be determined; secondly, steelmakers should, with this knowledge, produce the necessary data; and thirdly, on the basis of the data the engineer should determine the magnitude of stress which can be tolerated.

LETTERS AND LITERATURE

Letter to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

AMERICAN CONTROL

SIR,—The growing American control of British industries is a matter of concern and has been seriously discussed in Parliament. This, though a serious matter, is only a symptom of something much more serious and of much longer standing : our continued and increasing dependence on foreign—largely American—design and technical " know how."

For years past one has hardly been able to open a technical journal without reading that some British firm has taken out a licence for the manufacture, in this country, of some material product designed in America, Germany, Italy, Switzerland, or elsewhere. Every time we do this we lower our own standards of achievement. The increasingly dominant financial control of our industries seems to prefer, on the grounds of economy, to copy some foreign design rather than develop our own. As a short-term measure this may have some success, but in the long run it is disastrous. Even now the whole of our motor-car industry, aircraft industry, clock and watch industry, armament industries, and other precision engineering industries, on which the application of our scientific research depends, are entirely dependent on foreign designed and built machine tools, because the British equivalent just does not exist.

The present strong financial position of Switzerland, for example, is the natural result of their very strong technical position, which has been developed steadily for the last hundred years or so. Our present company law and financial and industrial structure, which ensures that financial considerations always dominate over technical ones, simultaneously ensures that, inevitably, technical leadership is lost and, equally inevitably, that financial and general control is then lost as well. The majority of members of boards of directors, even of highly technical concerns, are not qualified technically and only keep an eye on the profit. What really matters is the product, and if due attention is given to all aspects of this—including selling it—the profit, as a kind of by-product, is almost automatic.

Our industrial prosperity will never be soundly based until this principle is realised, understood, and acted on at the highest levels.

HUGH CLAUSEN

London, N.W.2,
May 4, 1959.

Book Reviews

Linear Structural Analysis. By P. B. MORICE, Ph.D., D.Sc. Thames and Hudson, Ltd., 30, Bloomsbury Street, London, W.C.1. Price 35s.

THE approach to structural analysis changes as different treatments are developed to solve the mathematical problems which generally arise when rigorous analyses are attempted. In this book Professor Morice introduces the method (relatively unused by structural engineers) of matrix algebra to the solutions of the equations obtained using an exact flexibility method of structural analysis for indeterminate structures.

In developing the influence coefficient method the general theorems of strain energy, on which it is based, are outlined in Chapter I. This is then applied in Chapter II to develop influence coefficient equations where the strain energy equations are re-written in terms of deflections of the released structure at the point of releases : from these the coefficients are derived. Several simple worked examples are given, as well as a table of product integrals for simple loading cases. Indeterminancy is then examined and a method given for arriving at it for any particular structure and from this the number of arbitrary constants is derived.

After dealing with the subject of matrix algebra, or rather some properties of matrices, the author gives at some length methods of computation, together with the way in which problems may be reworked or transformed and release systems chosen. This valuable contribution enables the considerable amount of arithmetic necessary in these solutions to be kept to a minimum. A final chapter is devoted to the use of digital computers for solving the large number of simultaneous equations which arise in this method. At this point it may be said that ten or twelve equations would appear to be on the high side for solution by desk calculating machines.

In general the approach of this book will be unfamiliar to those engineers lacking a good mathematical background, but this or similar approaches will necessarily have to be familiar to engineers of the future if electronic computers are to be used to the best advantage. The old approach of approximate methods is being superseded in this machine age. This book, which is based on a set of lectures given by the author, does not pretend to use original material, but it does for the first time bring a method of analysis which has been circulating among a relatively select few before a wider public. One feels, however, that Professor Morice has adopted an unnecessary academic approach in this well-produced book which may deter the engineer, whom one assumes he is trying to convert to a more analytical approach. Nevertheless, the book is to be recommended to those students and engineers who wish to have a very powerful method of analysis at their command.

Aircraft and Missile Propulsion, Vol. II. By M. J. ZUCROW. John Willey and Sons, New York. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 104s.

THIS is the second part of a three-volume work dealing primarily with the general performance characteristics of propulsion power units for aircraft and missiles. In general, the author confines himself to the study of turbo-jet, turbo-propeller, ramjet and rocket engines. The discussion is devoted solely to the analysis and thermodynamic aspects of the complete power plant. Nowhere does the author deal with the problem of component design, i.e. with the theory and design of compressors and turbines, &c. The division of subject matters is approximately 60 per cent to the compressor —gas—turbine jet—and jet propeller, 30 per cent to the rocket and a moderate 10 per cent to the ramjet.

Notwithstanding the heavy bias in favour of the gas turbine, nothing is mentioned of the by-pass and ducted fan engine. It is now some years since the former of these types materialised and one is therefore a little surprised at the omission. On the other hand, consideration of basic cycles includes studies of gas turbines more suited to the power station and marine engines. This extension of subject matter serves, however, to demonstrate the great improvements in economy to be expected from the intelligent use of inter-coolers and heat exchangers and offers food for thought. Additionally, it widens the appeal of the work and provides much useful study matter for those engaged in the less glamorous fields of locomotion and power supply. The turbo-jet engine is given the full treatment but surprisingly without mention of thrust augmentation by means other than the well-known afterburning or reheat methods. There is no reference to water injection systems now in common use in both British and American engines.

By comparison with the space devoted to the turbo-jet, that about the ramjet is very cursory. It is, of course, a much more elementary kind of unit in theory but perhaps more difficult to practise. It may be that non-access to experimental data has somewhat restricted the author in this section. It is in this section, however, that the author enters into the theory of the supersonic intake. The treatment of this complex component is broad and should serve as a useful introduction to the problems involved. Although the author does not appear to point it out, much of this intake matter also becomes applicable to the turbo-jet engines when in supersonic flight; in which a number now are. This intake discussion, in our opinion, is the most useful contribution of the ramjet section.

In the rocket section, the author deals very comprehensively with the basic theory but tends to bury it in a mass of figures, equations and tables of data. Having assimilated the general theory, this section takes on a handbook value.

Summarising, the author states in his preface that the book is for the use of students and those who are not specialists in propulsion. To such, it can be strongly recommended. To those already familiar with the subject, much useful data in the form of diagrams and curves is made available. Within the limits of the subject matter it is a very detailed and comprehensive contribution to the literature.

Conduction of Heat in Solids. By H. S. CARSLAW and J. C. JAEGER. Second edition. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 84s.

THE first edition of Carslaw and Jaeger's *Conduction of Heat in Solids* appeared in 1946 as the successor to Carslaw's earlier texts of 1906 and 1921. The second edition, reviewed here, has been prepared by Professor Jaeger alone, the senior author having died in 1954. It worthily upholds the reputation which this now classical series has enjoyed. The new edition is larger and better printed, and contains a great many new results. Chapters on integral transforms and on numerical methods have been added. The high standard of

clarity and elegance of the older sections is well maintained in the newer ones.

The Carslaw-Jaeger series is so highly, widely and properly esteemed that a critic must tread warily. Nevertheless, it must be admitted that the book under review does not provide all that the engineer would like to find. There are several reasons. The first is that the book is still, in organisation and presentation, primarily a mathematical text, despite the considerable effort that the authors have made to demonstrate the utility of the results by way of examples. This would not matter so much were if not for the fact that the analytical methods for studying heat flow, which take up by far the greater part of the text, are applicable only to bodies of quite simple shapes (slabs, cubes, cylinders and the like). In most engineering circumstances, the geometry is more complicated and numerical methods must be used. These, indeed, will usually yield an answer of sufficient accuracy more quickly than the analytical ones, even in the cases where the latter are applicable; for infinite series, though they can be written formally in a line or two, are not necessarily easy to reduce to numbers.

The above paragraph implies no disparagement of the authors, for it is not their main purpose to provide an aid to engineers. Besides, the engineer can learn much from the formal mathematical study of simple systems; the transient heating of a gas-turbine blade, for example, is quite similar to that of a plane slab, and the mathematical solution for the latter can be used for the former if only order-of-magnitude results are required. What is surprising, however, is to find that mathematical gaps can be found in the book. For example, the " source solution " for the linear heat flow equation, from which all the subsequent solutions are built up, is never derived at all; the authors merely quote and verify it, without giving the reader a clue as to how it was first discovered or how he should set about finding the solution to other equations of this kind. Most of the solutions in the book are " handed out " in this way; the reader does not find himself invited to participate in their creation.

Although the engineer's library therefore needs supplementing both by more practical books on heat conduction and by those giving a more intimate view of the mathematics of the subject, the fact remains that the new edition of the Carslaw-Jaeger volume contains by far the most comprehensive collection of theoretical results which is available. No one concerned with the prediction of heat flow in solids can afford to be without it.

Books Received

Your Retirement. Engineering Industries Association, 9, Seymour Street, London, W.1. Price 5s.

Heads and Threads Buyer's Guide, 1959. Peat, Marwick, Mitchell and Co., Queens Square, Middlesbrough.

Electrical Trades Directory, 1959. Benn Brothers, Ltd., Bouverie House, 154, Fleet Street, London, E.C.4. Price 63s.

Process Dynamics. By D. Campbell. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 84s.

Metal Fatigue. Edited by J. A. Pope. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 70s.

Electrical Safety. By H. W. Swann. Macdonald and Co. (Publishers), Ltd., 16, Maddox Street, London, W.1. Price 40s.

Ken Jones, Electrical Engineer. By D. O. Summers. Chatto and Windus, Ltd., 40–42, William 4th Street, London, W.C.2. Price 8s. 6d.

Berechnen und Entwerfen Der Schweisskonstruktionen. Second edition. By P. Schimpke and H. A. Horn. Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3, German Federal Republic. Price DM.33.60.

Obituary

F. E. WENTWORTH-SHEILDS

MR. FRANCIS ERNEST WENTWORTH-SHEILDS, whose death, we regret to report, occurred last Saturday, May 9, was closely associated with the development and operation of Southampton docks for over forty years. He was eighty-nine and, although he had been retired since 1936, from the position of docks engineer of the Southern Railway, he had continued to take an active interest in many matters concerned with civil engineering.

Mr. Wentworth-Sheilds was born in London and educated at St. Paul's School and at Owens College, Manchester. His first appointment, in 1888, was to the engineering staff of the Manchester Ship Canal, where he was engaged mainly on the construction of the Salford docks. In 1892, he went to Southampton as an assistant engineer on the dock extensions which were being undertaken, a project which occupied the succeeding four years. Thereafter, for a few years, Mr. Wentworth-Sheilds held other appointments, including those of resident engineer on the North Cornwall railway extension and resident engineer on the Bakerloo tube railway. He returned to Southampton in 1901 as resident engineer during the construction of the Trafalgar graving dock and deep water quay and, apart from a short period as resident engineer on the Isna barrage project in Egypt, the remainder of his career was devoted to the port of Southampton. Between 1907 and 1912 Mr. Wentworth-Sheilds was responsible, as chief engineer, for the design and construction of the White Star dock and the widening of the Trafalgar graving dock, combining with that task the duties of docks engineer to the London and South Western Railway, to which office he was appointed in 1909. He continued as docks engineer, Southern Railway, when the railway grouping was effected in 1921, retiring, as stated above, in 1936. During the latter years of his term as docks engineer, Mr. Wentworth-Sheilds had the responsibility of carrying out several important works at Southampton, among them being the construction of the new docks on the western shore and of the King George V graving dock. He was a member of the Southampton Harbour Board.

Mr. Wentworth-Sheilds became an associate member of the Institution of Civil Engineers in 1895 and was transferred to full membership in 1905. He was awarded the George Stephenson gold medal of the Institution in 1914, delivered the Vernon Harcourt lectures in 1921, and served the Institution as president during a particularly difficult year, 1944–45. His presidential address most appropriately dealt with the future of British ports. At the time, of course, the ports of this country were subjected to the severest stresses of the war years but future planning was, as Mr. Wentworth-Sheilds put it, " very much in the air." But, he also said, whether or not the ports were placed under the control of some central authority, it seemed right that schemes for their improvement should come from the local managements who understood the needs and the possibilities of their own ports. In the same address, Mr. Wentworth-Sheilds emphasised the importance of co-operation between engineers and all with whom they came into contact in the performance of their work. An engineer, he said, was required to conceive a structure which would fulfil a certain purpose and to get it built. In that task, he urged, it was essential to keep in mind those who would " benefit or suffer by its use."

SIR ARCHIBALD BOYD

SIR ARCHIBALD JOHN BOYD, whose death occurred at Beaulieu, Hants, on May 9, was chairman of Metropolitan-Cammell Carriage and Wagon Company, Ltd., and of The Patent Shaft and Axletree Company, Ltd.

Sir Archibald, who was seventy, was educated at Harrow and Trinity College, Oxford. In 1912 he entered the steel works of Cammell Laird and Co., Ltd., Sheffield, as a pupil, passing through the various departments, and becoming in 1913 assistant London manager of the company. After a period of military service in the first world war, he was recalled from France to become assistant general manager of the new ordnance factory which had been built by Cammell Laird and Co., Ltd., at Nottingham. In the 1920s Cammell Laird and Co., Ltd., started to manufacture railway rolling stock at the Nottingham factory, and subsequently acquired control of The Midland Railway-Carriage and Wagon Company, Ltd., and The Leeds Forge and Newlay Wheel Companies. Sir Archibald Boyd was appointed a director of these companies. In 1929 Vickers, Ltd., and Cammell Laird and Co., Ltd., amalgamated their railway rolling stock interests in the Metropolitan-Cammell Carriage and Wagon Company, Ltd., at Saltley, Sir Archibald becoming managing director in 1934.

During the second world war much of the company's capacity was devoted to the production of fighting vehicles, and from October, 1942, to December, 1943, Sir Archibald was seconded to the Ministry of Supply as Director-General of Tank Production. He received his knighthood in 1950, relinquished his office as managing director in December, 1953, and was appointed chairman in January, 1956.

G. A. ROTINOFF

WE record with regret the sudden death, after a heart attack, of Mr. G. A. Rotinoff, A.M.I.C.E., on May 2.

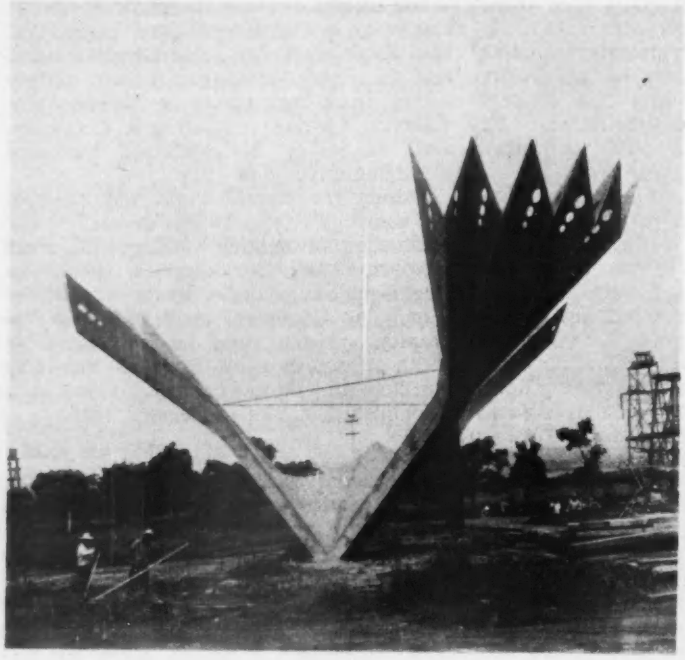
George Alexander Rotinoff was born in Russia on February 11, 1902, and was educated at Eton, proceeding to Cambridge to obtain his M.A. He served his apprenticeship in the oil fields of Rumania, and commenced his creative career with service in many parts of the world with his father's firm, driving the piling that carries his name.

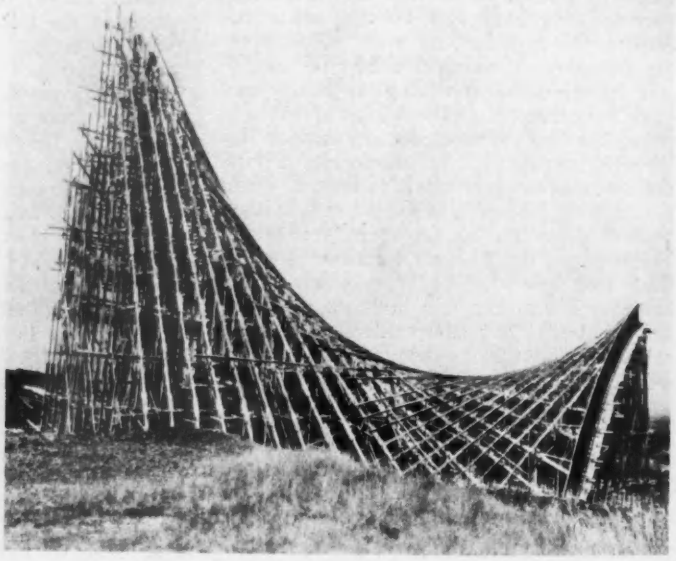
During his service with Dowsett-McKay he initiated the work of that firm on prestressed concrete railway sleepers and on open-cast coal mining. Subsequently he established his own construction company, followed by other firms which now constitute the Rotinoff Group : in later years he devoted himself largely to mechanical engineering, establishing a general engineering workshop during the war. After the war he undertook the design, development and manufacture of prime movers larger than any previous British vehicles. The tractors culminated in the 400 h.p. " Super Atlantic," the most powerful road vehicle in the world, while the " Viscount " truck is in service on long hauls in Australia.

Up to the time of his death, Mr. Rotinoff was taking an active part in engineering work : he had himself demonstrated his vehicles in the tank transporter role in Switzerland and other countries. Just twelve months ago he was present at the haulage of the heaviest load moved by road in this country, when Sunter Bros. beached the first heat exchanger for Bradwell nuclear power station : in our photograph of this event he can be seen standing beside his prototype " Atlantic." He is survived by a widow and an orphan daughter.

Mexican Shell Structures

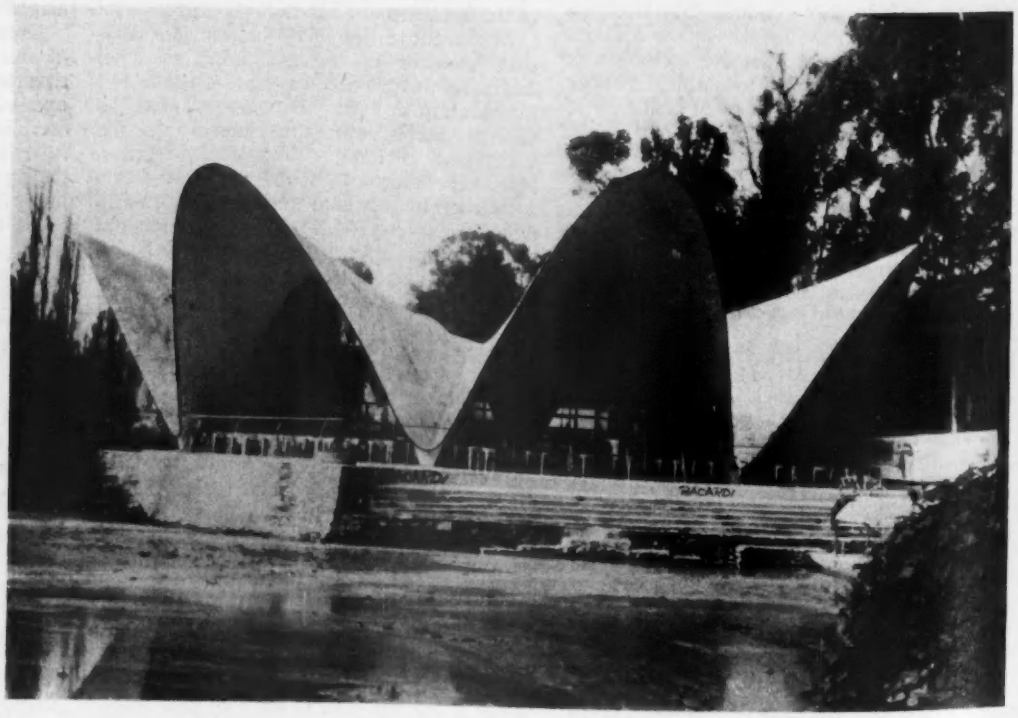
The illustrations on these two pages show recent shell structures built in Mexico by Felix Candela, who is at present on a lecture tour in this country. Candela considers that singly-curved structures such as barrel vaults are not true shells and should be called "laminar" structures. True shells are doubly-curved and of two categories, either synclastic (as in a dome) or anticlastic. In the latter category both the paraboloid and the hyperbolic paraboloid have straight generators and are thus in principle cheap and convenient structural forms. The hyperbolic paraboloid is the shape used in various ways in Candela's structures. A single surface of this kind forms the roof of the chapel at Coyoacan, Mexico City, (RIGHT) in which the elegance of line which can be achieved with the anticlastic shell is well shown.





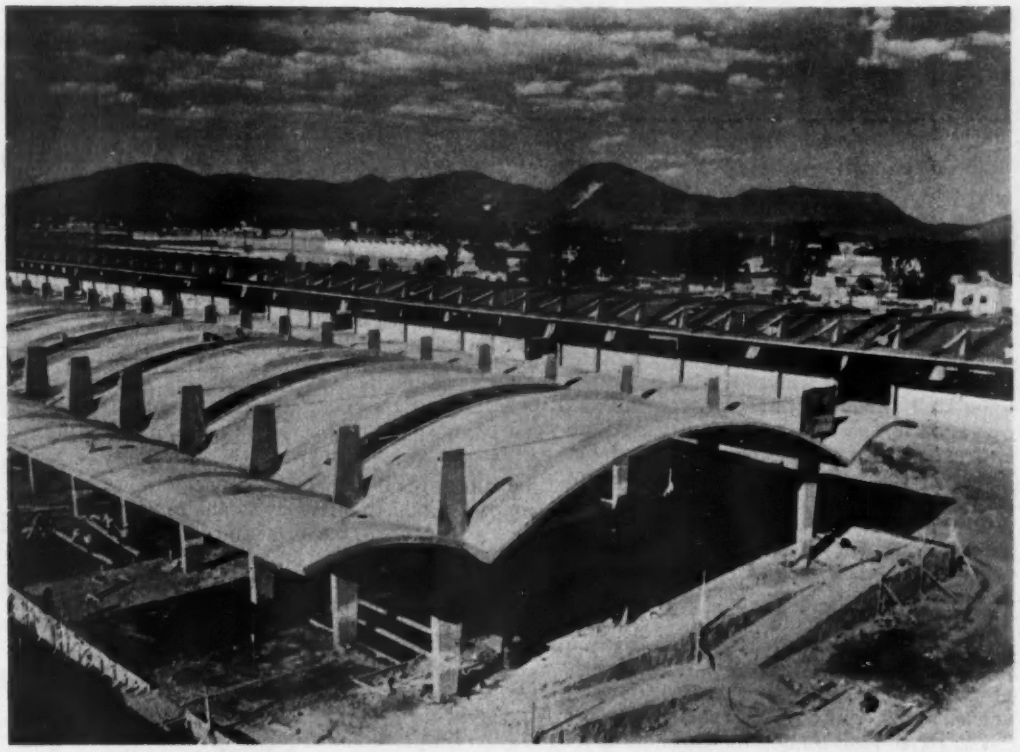
The formwork for a church at Cuernavaca, (ABOVE RIGHT), again shows one hyperbolic paraboloid forming the principal surface; the "peak" rises to a height of 100ft. The architectural feature (ABOVE LEFT), combines a number of hyperbolic paraboloids (e.g. each element of the "fans"). Compression ribs carry the loads to the ground at three points, and three steel ties complete the structural system.

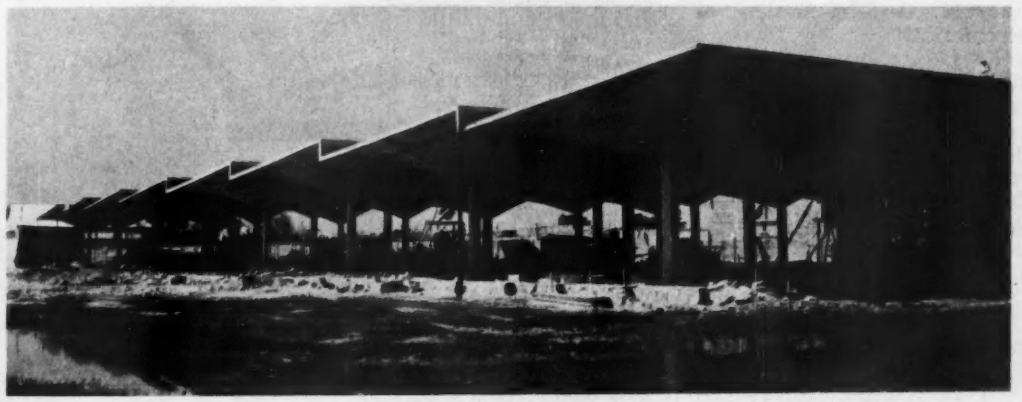
The restaurant at Xochimilco (RIGHT) is formed by the interpenetration of a group of shell surfaces carried at eight supporting points, the distance across the octagon which these points form being about 150ft. from point to point. Candela considers this to be his best structure. Note the absence of stiffening beams at the edges of the shells, the curved detail at each support, and the thinness of the shells.



Cheap construction has been a dominant motive in developing these shell surfaces, and on this page we illustrate examples which are utilitarian in character. The customs shed at Mexico City (RIGHT) is an early example and consists of cylindrical and conoidal shells. Note the cantilevered shells and the steel ties from the tops of the columns. The span between columns is 66ft, and the structure is built in independent 16ft lengths, to allow differential settlement.

The next two illustrations are typical of more fully developed warehouse designs. The basic element consists of four hyperbolic-paraboloid surfaces grouped together (so that in plan each one forms one quarter of the square or rectangle covered), and supported at the centre by a column. Tensile and compressive forces are then conveniently grouped along the lines where the shell surfaces join. This element, which Candela calls an "umbrella" is then repeated throughout the building. This design he considers to be the cheapest way of



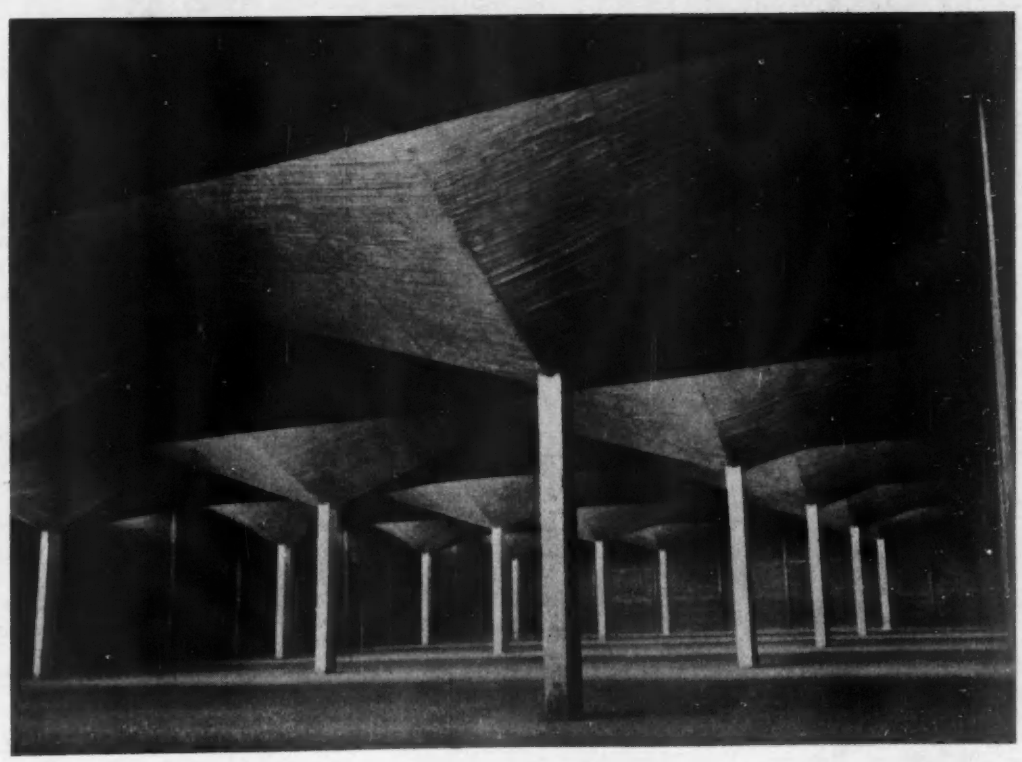


covering space. About 3,000,000 square feet of warehouse space has been built in Mexico in four years using this basic design. It has also been used for low-cost housing, and in both cases it combines cheapness with an attractive appearance.

An interesting variant of this principle is in the design of the foundations for the columns where the site possesses very poor subsoil, as in the case of the customs sheds shown at the top of the page. A foundation "shell" of concrete was in this case built to carry each column. The "shell" again comprised four hyperbolic-paraboloid surfaces centred on the column and formed by excavating to the stipulated shape; thus the column load is transmitted by direct compression through the "shell" footing to give a distributed load of low intensity on the soil.

Candela's achievements in shell roof construction started in 1951 with a corrugated vault-shaped roof, based on the "Ctesiphon" roofs which were built in this country during the war. The hyperbolic paraboloid is in his view the most advantageous form for shell roofs, since it allows great flexibility and many different combinations, and is easy to design and to construct. Its equation is the simplest equation of the second degree representing a surface, and hence the equations of equilibrium for the membrane stresses are readily soluble in every case.

Examples of hyperbolic-paraboloid roofs in this country and at the Brussels exhibition respectively were described in "The Engineer" of July 26, 1957, and May 16, 23 and 30, 1958.



Water Supply at Hull

The following account is largely abstracted from a paper presented to the Institution of Water Engineers by Mr. S. F. White. It deals with certain interesting features of the river abstraction scheme recently built to yield a supply of 12 m.g.d. to the city of Kingston-upon-Hull.

LAST Wednesday, the Institution of Water Engineers held a meeting at the Corn Exchange, Lincoln, at which two papers were presented dealing with different aspects of the major water supply scheme serving Kingston-upon-Hull, which is due to come into full operation this year. The scheme depends on abstraction from the River Hull, and has been built for a capital expenditure of about £2,500,000; it will yield 12 m.g.d.

River intakes, raw-water reservoirs, and a treatment works have been built about fourteen miles north of the city. From the treatment works, a 36in main extends for 11 miles to the northern outskirts of the city, and then 33in and 30in mains take the supply a further 5½ miles to its eastern parts. Aspects of the scheme of special interest to water engineers were concentrated upon in the paper "The River Hull Supply to Kingston-upon-Hull," by S. F. White, A.M.I.C.E., and the aqueduct was discussed in the second paper, "The Design and Construction of a 36in diameter Aqueduct with particular reference to adverse ground conditions," by K. J. Reynolds, A.M.I.C.E., and A. C. Wilson, A.M.I.C.E.

A sliding scale of abstraction is permitted from the river; two intakes were authorised, one on a tributary. The capacity of the two reservoirs—sufficient to tide over the estimated driest possible year plus an allowance for restriction on abstraction caused by launches at the shipbuilding yards at Beverley—is 370 m.g. Two areas where subsurface boulder clay was suitable were selected and developed as the reservoirs; the reservoir walls are of mass concrete.

The treatment works can deal with 16 m.g.d., and includes two "Accelators," each one capable of handling 12 m.g.d., which are amongst the largest yet built.

One of the accompanying diagrams, taken from Mr. White's paper, shows one of these devices, and the following notes are reproduced from his paper.

Accelators

The diameter at top water level is 100ft. The forced mixing of chemicals with incoming water and the recirculation of partly flocculated water are the main constructional features. The impeller pumps at about 2½ times the rate of flow through the tank, so that 1½ parts are recirculated for every part leaving the tank. In all probability, only chlorinated copperas (industrial ferrous sulphate) will be used as coagulant, but provision is made for the use of alum, with or without activated silica. The chlorinated water and ferrous sulphate solutions are mixed together in a small ageing and dividing tank in the control building between the Accelators.

Table I is a comparison between the Accelators installed and the normal sludge blanket type, only insofar as it affects this particular installation; but it may be of interest. It is assumed that the consumption of chemical is the same in each case, and that the total capacity is between 16 and 18 m.g.d.

The difficulty about standby arrangement can be overcome by building more and smaller Accelators, but the capital cost would then increase considerably. In these works the reduction in capacity in the event of a breakdown is not serious, as they are being run in parallel with three other stations, which could temporarily step up their output to make good anything over the output of one Accelator (12 m.g.d.).

The only other features of particular interest in the Accelators are (*a*) the provision of a pump to draw off sludge to the lagoons, and (*b*) the installation of a bypass.

The Accelators are founded directly on to Boulder Clay, and the main outer shell is designed completely in tension. Some settlement is expected on this foundation, and arrangements have been made for dealing with it.

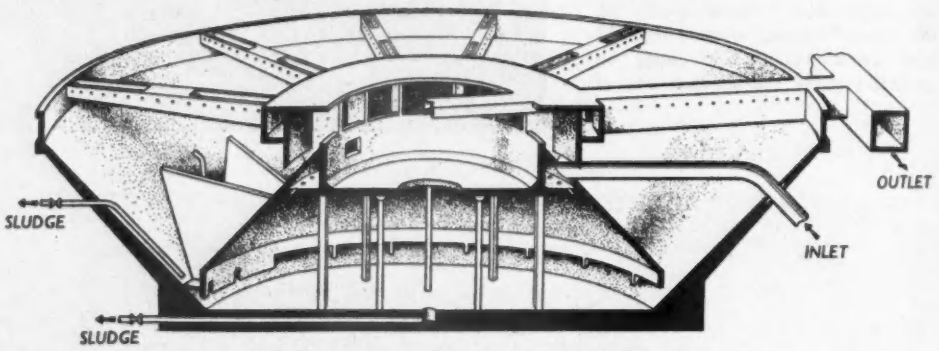


Diagram showing concrete construction of "Accelator" tank

Filters

There are twelve separate filter beds, arranged in pairs. For washing, a pair is taken out of service, while the other ten automatically take up the increased load.

These filters have fully automatic operation. The author did not wish to go into the much debated economics of automatic operation, but chose to point out that on this site labour is a particularly expensive item, and housing has to be provided for all staff.

Features of interest in the filters are:—

(1) Pneumatic operation of valves by compressed air.

(2) Syphon draw-off of washwater to enable relatively high rates of upwash and bed expansion.

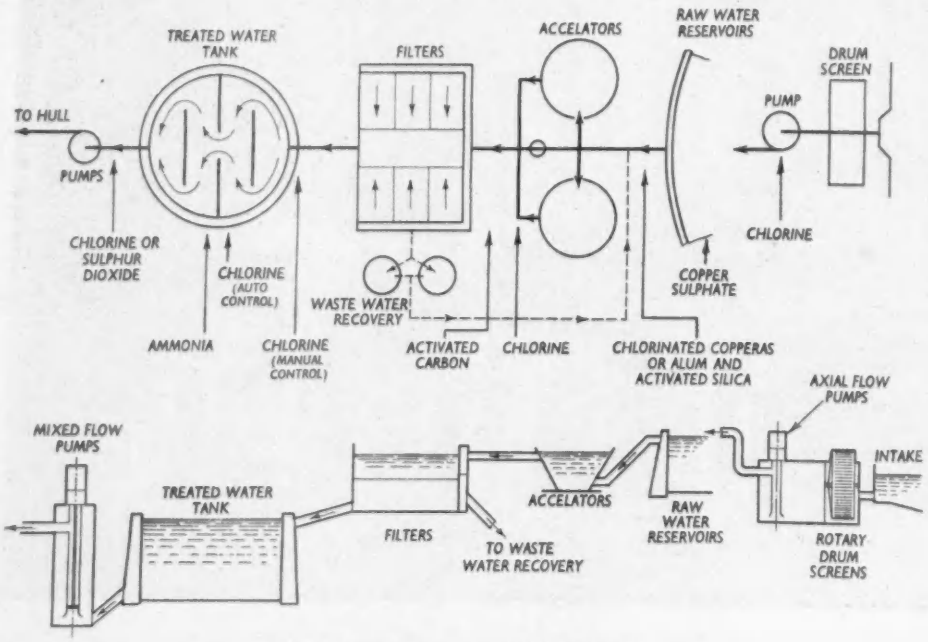
(3) The unusual method of providing upwash. Six pumps are used. First, all six come into operation in succession at intervals of a few seconds. This gives an initial high-velocity upwash of about 10 gallons per square foot per minute. Then four pumps cut out, leaving two running, to give the final wash, which is drawn off by the syphons. Times of washing are adjustable, so the arrangement is extremely flexible.

(4) Automatic control is effected either by head loss on the filter or by a time switch, should routine washing be required.

The normal filtration rate is 80 gallons per square foot per hour. This conservative rating will be very useful at times, should the clarification stage be omitted, and it also allows output to be increased to 16 m.g.d. when the need arises.

Provision is made for up to 15 p.p.m. of activated carbon to be added to the water before filtration, to remove tastes and odours which may arise with river-derived supplies.

Waste washwater is run into two recovery tanks in which rotating paddles keep the sediment in suspension. It is then pumped back into the Accelator inlet at a uniform rate.



Diagrammatic section and plan of works

Chlorination and Treated Water Reservoir

Three stages of chlorination are provided, two of them automatically controlled. Normally, two stages would be indispensable, and the third stage provides automatic chlorina-

TABLE I

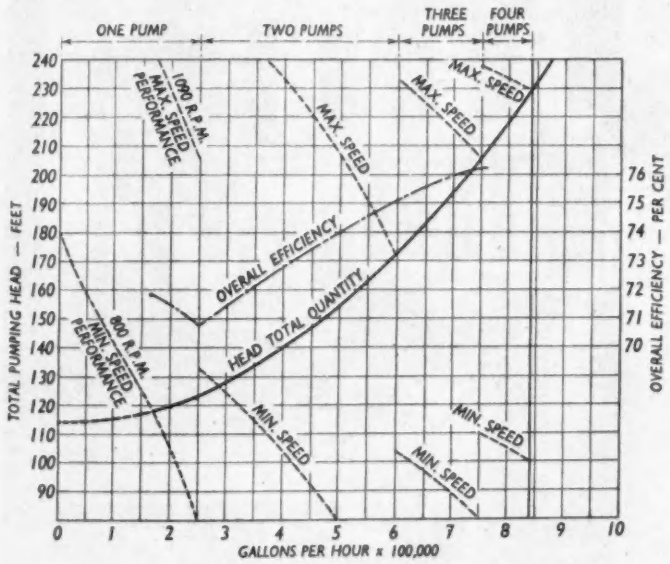
	Sludge blanket	Accelator
Building cost plus plant cost	£75,000 (estimated)	£66,081 (actual)
Upward flow	About 6ft per hour	9ft to 12ft per hour
Equivalent total head loss	4ft to 5ft	8ft to 10ft
Normal retention	1½ to 2 hours	1½ to 2 hours
Number of units	8 to 10	2
Sludge draw-off	16 to 32 points	6 points
Quantity of sludge	½ to 1 per cent	Not more than ½ per cent (manufacturer's estimate)
Standby arrangement in event of break down of a unit	Overloading up to 25 per cent enables two to three tanks to be taken out without affecting the supply	Overloading of up to 50 per cent is required to deal with 12 m.g.d. only
Operation	Many units to balance and operate. Dose of coagulant applied collectively. Blanket formed	Only two units to attend; dose can be applied individually. Recirculation can be varied at will. More stability in operation
Construction	Straightforward and quick to build	Complicated and relatively slow to build

tion, or dechlorination by sulphur dioxide, of the treated water before it passes through the 11 miles of pipeline into the Hull distribution system. There is no further chlorination at Hull, and a dose of ammonia can be given after the second stage to ensure that a "residual" can be maintained in the city.

The treated-water reservoir has a capacity of 5 m.g. and is divided into four parts by baffle walls. It also provides sufficient storage to balance the constant output of the treatment plant with the large fluctuations expected in the rates of pumping to Hull.

The construction of this reservoir provided one unusual problem. It is founded on a thin layer of boulder clay, in places only about 8ft thick. Below this clay is the chalk containing artesian water. In excavating for the reservoir, boreholes had to be sunk into the chalk and water pumped out to reduce the artesian water table. Permanent pumps have now been installed in the outlet house of the reservoir, so that whenever the water level therein falls to a dangerous value, these start up automatically to pump water out of the chalk and so reduce the artesian pressure.

Otherwise the construction of the reservoir is quite usual, with mass-concrete walls, two floor slabs, "flat" roof slab, and a mass-concrete dividing wall.



Variable-speed pump performance

PUMPING PLANT

The water provided by these works is pumped directly into the distribution system through a long length of pipeline. This feature has had the consequence that it has led to a complicated pumping system. At peak hours of water demand, up to 750,000 g.p.h. will be required with a total pumping head of 205ft. At minimum demand, as little as 200,000 g.p.h. will be taken with a pumping head of only 120ft. The illustration above shows the characteristic of the pumping main with the pump performance curves.

There is no suitable site for a large service-reservoir in Hull which could balance this supply, and it is impossible to operate the other three pumping stations so as to cut down the peak demand to a more economical figure. Details of the proposed initial method of operating the four stations together are illustrated below.

At first, this station will work at a very reasonable load factor, but as demand increases, the variation in output will steadily increase, even though two of the existing stations can close down altogether at night.

To provide the pumping characteristics required, five vertical-spindle two-stage mixed-flow pumps have been installed. Each is equipped with a 330 h.p. variable-speed a.c. commutator motor and can deliver between 4 and 6 m.g.d. Despite the wide range of duty this combination has an efficiency ranging from 70 to 76 per cent. The control of this type of motor is by shunt induction regulation of rotor circuit voltage, at supply frequency.

The induction regulator voltage can either oppose or augment the rotor voltage, thereby giving both sub- and hyper-synchronous speeds.

The raw-water pumps, at the intake and the treatment works, are axial-flow vertical-spindle pumps with slipring motors.

In general, most other pumps are either of the vertical-spindle type or have positive suction heads. This has proved necessary because of the wide range of suction head on most pumps, and the automatic operation of a large proportion of them.

It is obvious that pumping to Hull is the largest single item, and that this reaches its peak when grid electricity is dearest. To reduce this cost, and to provide standby in the case of power failure, a total of over 1000kW of diesel generating plant is installed. This will be operated mainly during "on-peak" hours to cut down maximum demand charges to those obtaining in "off-peak" hours. To assist this, the intake and transfer pumps will not be run during peak hours, and the automatic filter-washing plant will be switched off. For this reason, the intake pumps, as well as all the other large pumps, can be started and stopped from the control room in the main building.

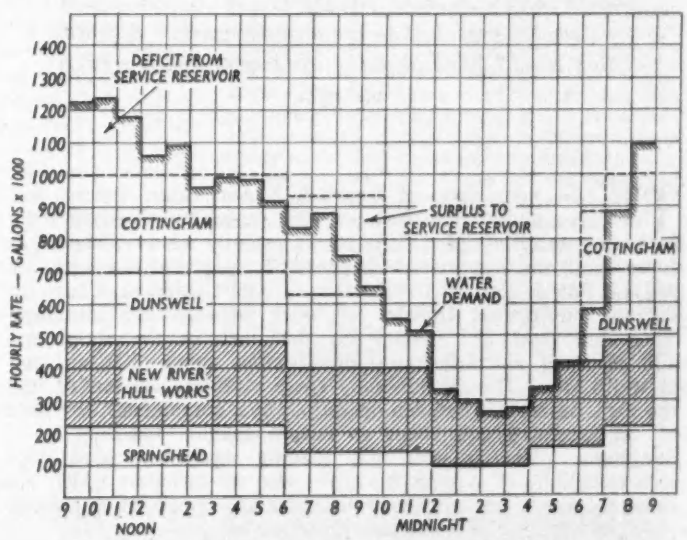
TABLE II—*Power Requirements and Generating Plant*

Schedule of basic power requirements (all figures in kilowatts)

Description	Installed, kW	Average use	Maximum
Pumping to Hull	1250	390	1000
Intake works	175	70	165
Transfer pumps	165	50	120
Treatment plant	160	35	160
Diesel and pump auxiliaries including workshop equipment	70	25	40
Heating and lighting	175	40	130
Supply to housing	70	30	70
General drainage pumps, &c.	35	5	30
Totals	2100	605	1715

For ease of operation the following features are provided in the control room:—

(1) Peak-hour warning light and alarm.
(2) Total power on busbar meter.
(3) Total power available meter.
(4) Total grid power meter.
(5) Hull mains pressure indicator with warning.
(6) Diesel speed controls.
(7) Variable-speed pump controls.
(8) Controls for shutting off many non-essential loads.



Supplies to Hull; typical mid-week summer day, consumption 19,250,000 gallons.

Proposed method of operating the four pumping stations

The switchgear is specially designed for the diesel generating plant to operate in parallel with the grid, both being fed to common busbars. There is two-way feeder protection to prevent feed-back into a line fault and to protect the station switchgear. An 11kV supply is taken from the grid, and two 500kVA transformers are installed, transforming down to the station operating voltage of 415.

The low-voltage switchgear is the air-break type of 25MVA rupturing capacity. This is arranged in two tiers, and gives an extremely compact layout. As a total fault power of more than 25MVA is available, a bus section switch is provided, and Castell interlock keys prevent both transformers being switched on to common busbars. This arrangement has led to some complication in the auxiliary switchgear, and important sections of the plant are fed from both sides of the busbars.

In general, a three-wire system of distribution is used. This has led to some complications, but has brought about considerable saving in capital cost.

The author was, however, of the opinion that generally it is better to have the four-wire system, except where, on stations such as this, there are relatively long cable runs to the different parts of the works.

A further saving in capital and running costs has been obtained by transforming current for the intake works up to 3·3kV before transmitting along the 1¼ miles of cable.

Voltage regulation and earthing is of course provided by the grid supply, but in case the diesel generating plant should be operated by itself, separate earthing facilities and voltage regulators are fitted.

Generating Plant

There are three sizes of diesel generating sets, two at 124kVA, two at 340kVA, and one at 435kVA. Only the latter is a " blown " engine. The piston speed is only 1208ft per minute, and the rating is conservative. The average overall efficiency is between 30 and 34 per cent.

The question of waste-heat recovery for heating the building was carefully investigated but found to be impracticable because of the intermittent use of the engines.

The cooling system uses Serck heat-exchangers situated in the sump from which the treated water is pumped to Hull.

An ample supply of fuel is stored to tide over periods when the site is isolated during the winter.

Acknowledgments

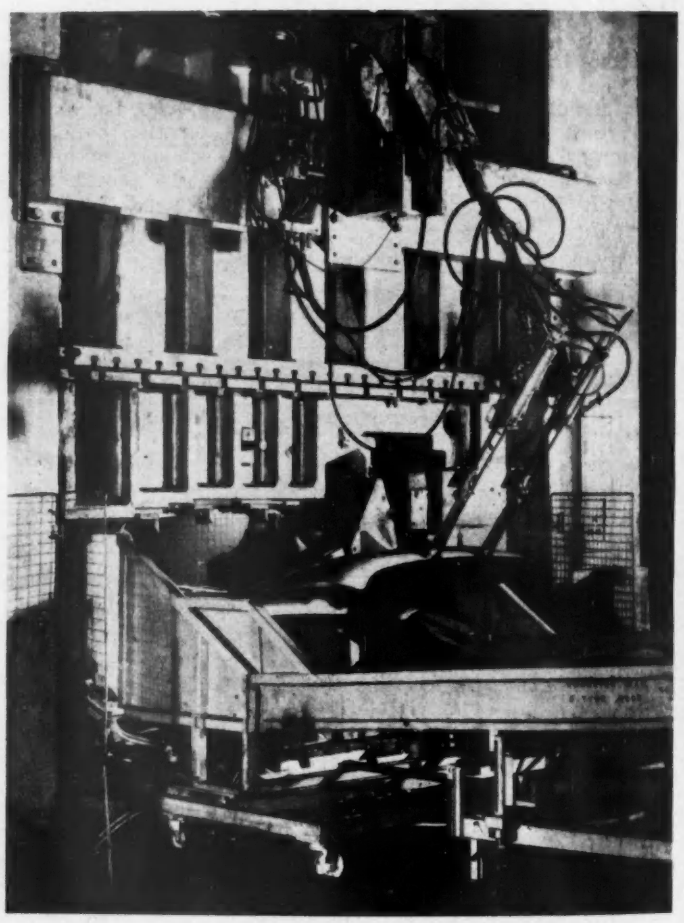
The consulting engineers for the scheme are Messrs. G. H. Hill and Sons (Manchester).

List of Main Contractors

Civil engineering works, A. E. Farr, Ltd. (£1,318,500). Sub-contractors: concrete pipes, Stanton Ironworks Company, Ltd.; drum screens, F. W. Brackett and Co., Ltd.; heating, A. F. Snelling, Ltd.; lighting, Booker and Tarran, Ltd.; cables, Enfield Cables, Ltd. Access roads, A. Monk and Co., Ltd. (£42,800). Site houses, T. Wright and Sons (Hull), Ltd. (£47,500). Pumping and generating plant, Sulzer Bros. (London), Ltd. (£172,000). Sub-contractors: Motors, alternators, switchgear, transformers, Metropolitan-Vickers Electrical Company, Ltd.; diesel engines, Ruston and Hornsby, Ltd.; variable-speed a.c. commutator motors, Laurence, Scott and Electromotors, Ltd. Treatment plant, the Paterson Engineering Company, Ltd. (£109,570). Chlorination plant, the Paterson Engineering Company, Ltd., Wallace and Tiernan, Ltd. (£16,300). River weirs, sluices, valves, &c., Glenfield and Kennedy, Ltd. (£34,020). Steel pipes, Stewarts and Lloyds, Ltd. (£9040). Cast iron pipes, the Staveley Iron and Chemical Company, Ltd. (£4110).

Mechanical Work Handling in a Press Shop

The use of automatic loading, ejecting and extracting devices and inter-press transfer systems in the new press shop of Vauxhall Motors, Ltd., Luton, is estimated to give a saving of over 150,000 *man-hours a year. The automatic transfer system installed was supplied by Maxam Power, Ltd., and is compressed air operated throughout. A typical " Iron Hand " fitted to one of the presses can be seen on the right.*



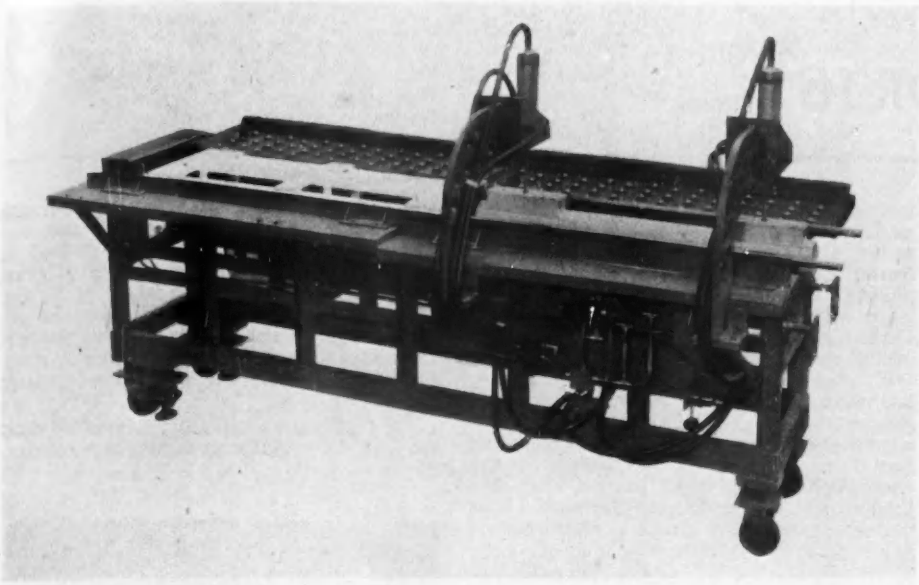
THE new press shop of Vauxhall Motors, Ltd., Luton, was described in our issue of May 9, 1958, (pages 690–694) and in the course of another visit to the works recently we were shown in fuller detail the compressed air operated equipment developed by Maxam Power, Ltd., of the Holman Group, Camborne, Cornwall, for the mechanised transfer of work between the machines. There are some 222 presses on the lines in the shop, and 130 of these machines range in capacities up to 1500 tons and in width from 72in to 156in. These machines are loaded and the work transferred between operations by a comprehensive system of air operated equipment to reduce manual handling to a minimum. The transfer and loading equipment used consists essentially of systems of valves and air cylinders which are remotely controlled and synchronised with the stroke of each press.

All of the medium and heavy presses of up to 1500 tons capacity are fitted with automatic jaw design extractors, or " Iron Hands." These devices extract the pressings from the dies and place them either on inter-press transfer units or conveyors. The air operated equipment cycle is controlled by an electro-pneumatic system from an assembly of switches actuated by a rotating camshaft driven by gearing in synchronisation with the eccentric shaft of a press. In its sequence of operation an extractor mounted at the rear of a press moves forward to grasp a pressing in its jaws and lift it clear of the die immediately the press ram moves up. The arm supporting the jaw is then moved out from the press and at the completion of this movement the jaw opens to release the pressing on to a conveyor or turnover machine. The arm is then returned to its original position ready for the next press cycle.

Each extractor assembly includes three double-acting air cylinders, a solenoid valve and two air-controlled valves, two bleed reservoirs with restrictor needle valves for timing purposes, and two micro-switches. One micro-switch is operated by the rotary cam switch mounted on the press, and the other, mounted on the jaw, determines the point when the pressing is released.

At the beginning of the cycle the arm is in the resting position and the jaw is open as illustrated. As the press ram moves up on completing a pressing the rotary cam operates a micro-switch to energise solenoid valve *A* and admit air to jaw cylinder *B*, causing its piston to move forwards. At the same time air passes through two sets of restrictors and reservoirs to operate valves *D* and *E*. Following a short delay (which can be varied from 0–7 seconds) air passes to the bottom of cylinders *F* and *G*. Cylinder *F* raises the jaw and the pressing it holds clear of the die while cylinder *G* moves the arm out from the press. During the outward stroke of the arm a second micro-switch is tripped which de-energises the solenoid valve *A* and allows air to pass to the front of jaw cylinder to open the jaw and release the pressing at the predetermined point. De-energising of solenoid valve *A* also causes, after a time delay, the cylinders *F* and *G* to return the arm and jaw to the position of rest at a controlled speed.

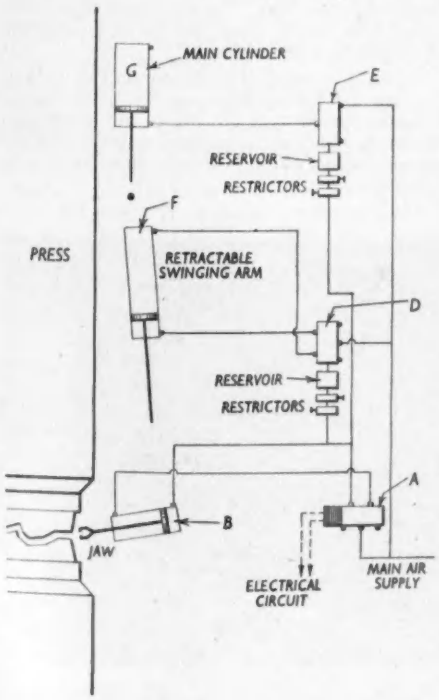
Full use is made of mobile, pneumatically-operated loading machines and prebending and turnover equipment, all of which are operated by Maxam air cylinders, valves, micro-switches, &c., which are synchronised with the stroke of individual presses though their rotary cam multi-switch assemblies. Typical of the loading machines is the standard portable shuttle loader which can be seen in operation in one of our illustrations. These machines are operated by two double-acting air cylinders, a solenoid valve, two roller-



Pneumatically controlled prebending and loading machine used to form sheet steel before it is fed into a power press

actuated valves and an air-operated valve. When the solenoid valve is energised by the rotary cam switch of the press, air passes to a cylinder which lifts the shuttle carriage vertically at the commencement of a cycle. The shuttle, when lifted to receive a steel sheet or pressing, actuates a roller valve which causes the second cylinder to move the shuttle carriage forwards horizontally to the press orifice and load the work on to the die. At this point the rotary cam switch de-energises the solenoid valve, which causes the shuttle raising cylinder to retract and lower the shuttle. At the end of this stroke the second roller valve is actuated causing the shuttle carriage cylinder to retract and return the carriage horizontally to its original position ready for the next cycle.

In the production of " U " section pressings the steel sheet has first to be bent to the appropriate shape to prevent cracks and draw lines appearing as the result of pressing. For this class of work the design of pneumatically-operated pre-bending and loading machines shown in another of our illustrations has been developed. Steel sheets are fed by hand on to the platform of this machine and they pass one at a time, in synchronism with the press stroke, between two sets of lateral roller bars. Depending on the shape required and the amount of angle or curve to be given to the sheet, the bars are positioned and the distance the top bars descend is adjusted. At a selected point the top roller bar is pressed down on to the sheet by air cylinders and it forces the sheet between the two lower bars. If a flat overlap is required there are provided two additional top bars which descend and level off the protruding metal each side of the bent section. The formed sheet is then lifted by air cylinders and a small air cylinder controlled clamp grips the metal When the press reaches the end of its cycle and the dies are apart the clamp and carriage move the shaped steel sheet into the press to place it in position on the lower die. The loader platform is designed to carry three sheets at a time and the continuous operation of the machine is synchronised with that of the press through the main rotary cam microswitch unit.



Air and **electrical circuits of an extractor unit**

On a number of the presses the lower dies are fitted with compressed air operated ejectors. There is also the problem of side-piercing work in dies with angled sides opposed to the direction of thrust of the press rams: in this application air cylinders are built into the dies at right angles to the surfaces to be pierced. Punches are fitted to the pistons of these cylinders and their operation is controlled by the main rotary cam switch of the press.

By this use of basically standard and interchangeable mechanical handling equipment and an effective method of synchronisation and control, there has been provided a flexible and adaptable transfer system on all of the twenty-six press lines in the shop. The Maxam equipment used throughout, being largely interchangeable, reduces the number of spare components that need to be stocked to a minimum, and considerably facilitates maintenance and overhaul work when necessary.

Supersonic Airliner Project

THE SOCIETY OF BRITISH AIRCRAFT CONSTRUCTORS made last week the following statement of policy.

The report of the Supersonic Transport Aircraft Committee does not examine the economic or prestige aspects of a British airliner travelling at about Mach 2 in company with a possible foreign airliner travelling at Mach 3. It was also beyond the scope of the report to examine the impact of the project upon Government policy of support for the aircraft industry's work at large.

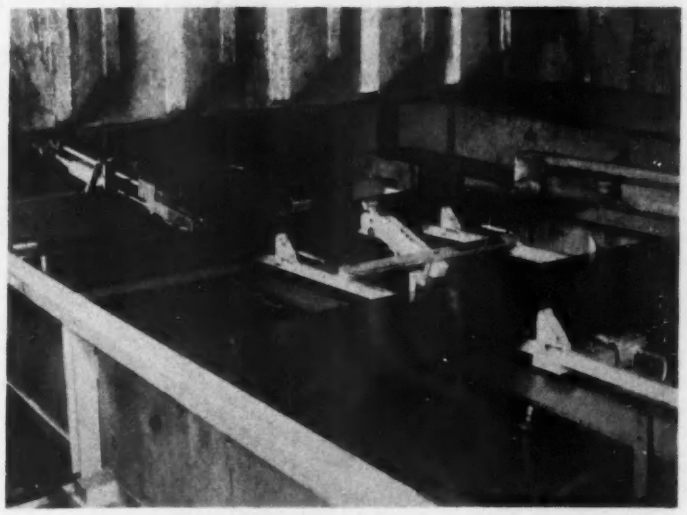
We have clearly reached the point where it is necessary to define specific directions of effort. Two main directions may be distinguished. First, there is investment in projects at subsonic speeds, where each project can be, and should be, judged primarily by the prospect it offers for sale of aircraft at home and abroad so as to achieve the fullest possible production lines and employment.

Secondly, there is investment in projects which go into supersonic speeds, where the investment, judged by economic criteria, is less direct, though the indirect elements of research and development, and of prestige, are greater.

We hope that it will be possible to pursue both directions of effort. It has to be recognised, however, that no aircraft firm could put risk capital into the development of supersonic airliners on the basis that it must recover costs and make a profit through sales to airlines. To the best of our knowledge, no American aircraft firm is venturing such risks, since the primary cost of development is being borne on account of military aircraft paid for by their Government.

On the technical side, nothing but good can come from active pursuit of the research and development problems associated with the supersonic airliner ; from the manufacturers' aspect, the financial and economic considerations have not yet been studied. In our opinion, economic and further design studies must be done if the various factors are to be properly assessed.

In the years which lie between the present and the time when supersonic transports become available it is almost certain that there will be further substantial buying by the airlines. Unless the British industry can obtain its share of those orders, the possibility of obtaining worthwhile orders for supersonic transports will be seriously prejudiced. We are convinced that a determined drive in the subsonic field must be regarded as a necessity.



Part of a standard shuttle loader which carries three steel sheets ; the sheet nearest to the press is fed on to the die by the air-controlled jaw shown about to grip the sheet

SHORTER REPORTS

Iron and Steel Institute

THE ninetieth annual meeting of the Iron and Steel Institute was held in London on Wednesday and Thursday, May 6 and 7. The annual report of the council, which was submitted to the meeting, showed that at the end of 1958 the total membership of the Institute was 5098, the highest total in its history. The retiring president, Mr. C. R. Wheeler, presented the Institute's annual awards, as follows: Bessemer gold medal to Professor Bo Kalling, in recognition of his distinguished contributions to the physical chemistry of steelmaking; Sir Robert Hadfield medal to Mr. Albert Jackson for his notable contributions to metallurgy and metallurgical education, including particularly the development of the "Ajax" oxygen process; Andrew Carnegie silver medal to Dr. P. Vasudevan, for a paper on "The Kinetics of Bainite Formation in a Plain Carbon Steel," and the Williams prize to Mr. H. C. Child for a paper on "Vacuum Melting of Steels."

Mr. W. Barr was installed as president in succession to Mr. Wheeler, and delivered an address, on Wednesday morning, which dealt with progress and development in the application of steel plate. Extracts from the address are printed on page 766 of this issue. There were three sessions on Wednesday and Thursday for the discussion of papers, the subjects covered being "Recent Applications of Oxygen to Steelmaking," "The Mechanism of Bainite Formation," and "Hydrogen in Steel."

The Institute's annual dinner was held at Grosvenor House on Wednesday evening, May 6, with the president, Mr. W. Barr, in the chair. The principal guest was Mr. J. S. Maclay, Secretary of State for Scotland, who proposed the toast of "The Iron and Steel Institute and Industry."

Preservation of Two Contractors' Locomotives

THE Industrial Locomotive Society, with the co-operation of the County Surveyor of Devon County Council, has acquired for preservation the steam locomotive "Pixie."

This locomotive (below) was built by Kerr Stuart and Co., Ltd., of Stoke-on-Trent, in 1922, makers' number 4260, and is a representative of that firm's popular "Wren" class. It is an 0-4-0ST with outside cylinders 6in by 9in with 1ft 8in diameter driving wheels and weighs approximately 3½ tons, the gauge being 2ft. "Pixie" was probably supplied new to William Muirhead, MacDonald Wilson and Co., Ltd., contractors for the Southend arterial road construction, 1922–24. But this locomotive had a short life in the direct contracting industry, as it was in T. W. Ward, Ltd.'s yard at Grays by 1927. In 1929 it was sold to Devon County Council, Bideford, and was probably used on some of the council's road works schemes. At a later date it arrived at Devon County Council, Wilminstowe roadstone quarry near Tavistock, where it was used until 1950, when it was replaced by lorried transport and where it lay out of use until recently acquired for preservation. The locomotive now lies in a member's garden in Hertfordshire, where it has been successfully steamed. The accompanying photograph shows "Pixie" on the lorry that brought it from Tavistock. Restoration and maintenance has been carried out by members of the Industrial Locomotive Society.

"Pixie" itself has no special historical interest but is typical of the period when narrow gauge railways were considered essential for public works contracts and quarry work. In the early thirties, the 2ft (or 60cm) gauge steam locomotives were fighting their losing battle with the petrol locomotive. The arrival of diesel traction and, later, earth-moving equipment, has all but annihilated them and it was for this reason that the Industrial Locomotive Society decided to preserve a comparatively modern engine.

There has also been acquired for preservation the steam locomotive "Triassic." This locomotive has been acquired through the kind co-operation of the Rugby Portland Cement Company, Ltd., Rugby: the locomotive is held in trust for the Industrial Locomotive Society. It now stands in the garden of Mr. J. B. Latham's house at Woking. Technical details of the locomotive are: 0-6-0ST outside cylindered 7in by 10in and gauge 2ft; the locomotive was built by Peckett and Sons, Ltd., of Bristol, in 1911. makers' number 1270, for Kaye and Co., Ltd. (predecessors of Rugby Portland Cement Company), for use in the quarry of the Southam Works, south of Coventry. "Triassic" is one of six very similar locomotives built for use at this works and was possibly designed specially for this purpose. But the general design was certainly used in many quarries and plantations, both in this country and abroad. Many examples, no doubt, still exist but they are gradually being replaced by diesel locomotives and road transport.

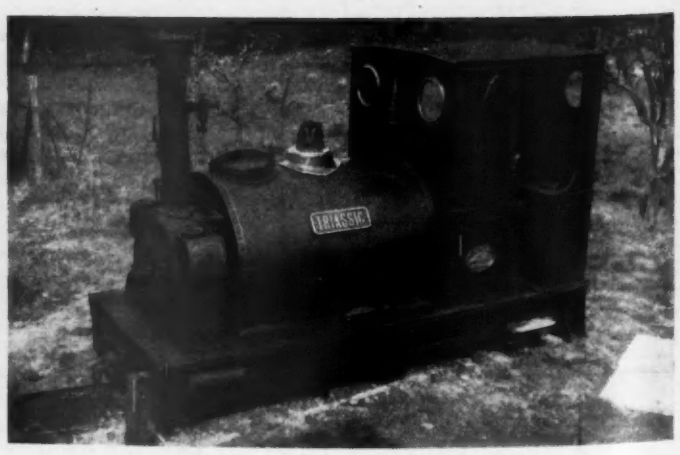
Screw Elevator

A SMALL screw elevator for handling bulk materials at rates up to 3 to 12 tons an hour when driven by a 1½ h.p. motor, or ½ to 3 tons per hour with a ¾ h.p. motor drive, is now made by Russell Constructions, Ltd., Russell House, Adam Street, London, W.C.2. In this elevator, to be seen in the accompanying illustration, two opposed spirals in the feed hopper base feed the material into an inclined elevating spiral which carries the material up to a height of 5ft 6in. An extension can be fitted to increase the discharge height to 11ft. Drive from the motor is transmitted through a torque converter by which the speed of delivery can be varied over a large range.

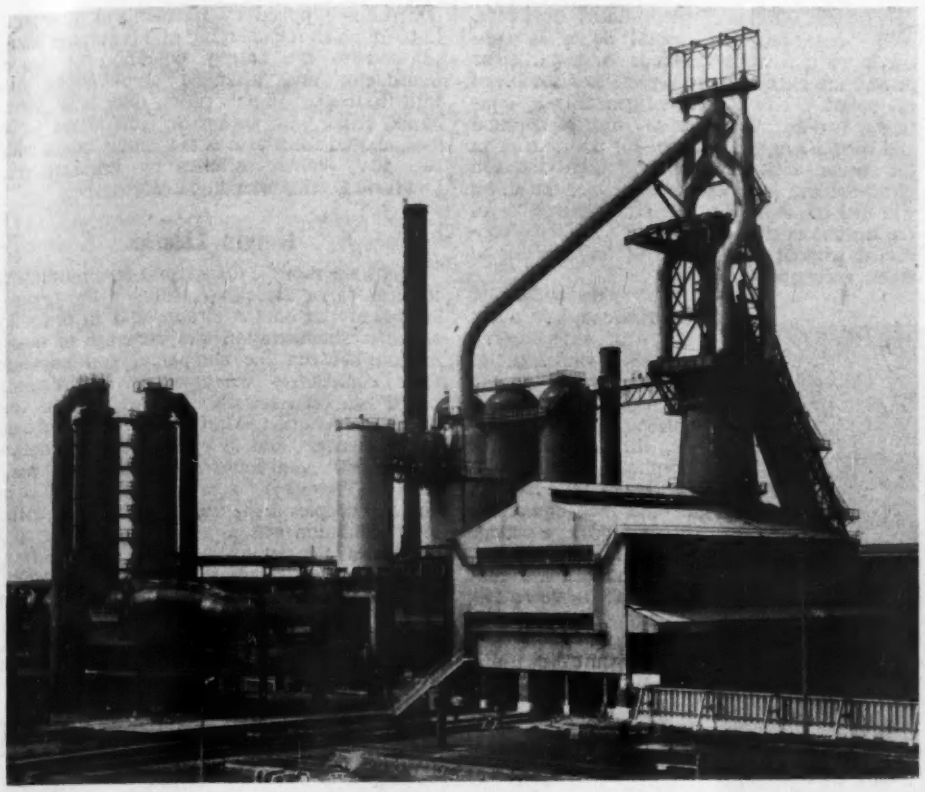
The feed hopper has a capacity of 4½ cubic feet and, by partitioning it into two compartments, two different materials can be mixed as they are delivered by the feed spirals to the main elevator. By varying the pitch of these feed spirals, materials can be mixed in any required proportion. The horizontal feed spirals run at a fairly low speed, and the elevating spiral at a speed four times greater.

When it is required to dismantle the machine for cleaning, the operation can be carried out in a few minutes without the use of any tools. All of the bearings are effectively sealed to prevent contamination of the materials being handled by lubricating oil.

Small screw elevator with a capacity for up to 3 tons per hour, and capable of mixing two different materials as they are fed to the elevating screw



These two contractors' locomotives, one, "Pixie," built in 1922, the other, "Triassic," in 1911, are now being preserved by the Industrial Locomotive Society



The No. 5 blast-furnace at Margam has a hearth diameter of 31ft. Its iron-making capacity is over 10,000 tons a week

Margam No. 5 Blast-Furnace

LAST Friday, the new No. 5 blast-furnace was blown in at the Margam works of The Steel Company of Wales, Ltd. This furnace, which is illustrated herewith, has a hearth diameter of 31ft and a working volume of 59,365 cubic feet ; its iron-making capacity exceeds 10,000 tons a week. The furnace is 248ft high and stands alongside the No. 4 furnace. The stockyard for the latter has been extended to cover both furnaces and now has a capacity of 250,000 tons of iron ore. Ore from the wharf and from the home ore tipplers reaches the stockyard by overhead conveyor and its distribution over the stockyard is achieved by means of a stocking-out bridge ; a reclaiming bridge lifts the ore from stock and deposits it on to a conveyor system to be carried to the bunkers. As the weekly requirements of foreign ore will be in the region of 63,500 tons per week, a fifth transporter unloader has been installed at Margam Wharf. An important point about the new furnace is that the layout makes it possible to operate entirely on sinter if this should be required in the future. For this purpose a conveyor system links the ore preparation plant direct with the sinter bunkers at No. 5 blast-furnace.

Air for the new furnace is provided by a 125,000 cubic feet per minute axial flow turbo-blower. To preheat the air there are three 140ft high stoves each fitted with automatic valve change. The stove shells, furnace top, gas cleaning plant and mains have been designed for possible high top pressure operation. When the furnace is tapped, iron is run into 180-ton capacity torpedo mixer ladles, each 55ft 6in in length. These ladles are fitted with their own tipping equipment powered by a 15 h.p. electric motor. The slag from the furnace is run straight into pits alongside the furnace, from which it is loaded by mechanical digging equipment into road vehicles for transport to the tips.

Owing to the nature of the ground on which the furnace and ancillary plant stand, it was necessary to drive 181 special piles to support the foundations ; these piles, some of which were 39in in diameter and others 35in, were driven to a depth of 70ft to 80ft. For the construction of the furnace foundation block, 9680 tons of concrete were used, including 1000 tons of refractory concrete. The portion of the foundation block below ground is constructed of sulphur resisting cement to counter any attack by ground water which may be contaminated by the nearby slag pools. The furnace is carbon-lined to lintel level and in the hearth has carbon side walls with a refractory centre. It was designed and built by Ashmore, Benson, Pease and Co.

Television in a Steel Works

THE installation of fifteen closed-circuit television channels has recently been completed by Marconi's Wireless Telegraph Company, Ltd., Chelmsford, in the new rolling mill at the Port Talbot works of The Steel Company of Wales, Ltd. The increased capacity derived from the new mill necessitated additional soaking pits, and consequently required the transport of ingots from the soaking pits to the mill to be speeded up. Under the old system, an ingot was taken out of the soaking pits by a crane and placed on an ingot buggy which carried it to the rolling mill. Now, a shuttle car runs on the same track as the ingot buggy and operates between the buggy and the mill. First, the buggy is positioned opposite a pair of soaking pits from which the ingots are to be drawn and the shuttle car is brought up to it. A red-hot ingot is then placed in the buggy by a crane and the operator upends the ingot on the buggy by remote control and runs it into the shuttle car by means of rollers. A second ingot is then placed in the buggy and the process repeated; the shuttle car carries these two ingots to the mill and returns quickly to the buggy which by that time may have been moved to another pair of soaking pits.

The shuttle car and the buggy are electrically controlled from a central pulpit and the meeting of the two vehicles may occur at any point up to a distance of 1000ft from the operator in the pulpit; nevertheless, it is, of course, essential for the operator to have a clear view of what is happening during these operations. As the distance is too great for this to be done unaided, it was decided that the use of television would best overcome the problem. In order to give a clear and accurate view showing every detail of the transfer of ingots, the viewing cameras must be at right angles to the running track and to effect visual coverage of the several hundred feet of track over which the vehicles may meet, fifteen cameras each with special wide angle lenses have been installed. Each camera surveys about 45ft of track, so that the total coverage is approximately 700ft. The cameras are mounted in line with an outside wall of the rolling mill, looking inwards and downwards at an angle through apertures at the relevant length of track; they are protected from the weather by canopies. The camera outputs are fed by cables to control racks in a basement of an adjacent building and thence to fifteen monitors which are installed in the operator's pulpit as shown in the accompanying illustration. In this way the operator concerned is presented with a composite picture of the whole length of track over which the two vehicles can meet.

The installation posed several problems, notably those of the small amount of natural light available in the area and the high ambient temperatures (over 160 deg. Fah.) which at times occur. The camera channels are Marconi BD871 equipments.

Television monitors in rolling mill operating pulpit. The operator has a composite view of approximately 700ft of rail track, the far end of which is about 1000ft away

Trunk Dialling at Railway Exchange

FACILITIES provided in a new private automatic branch telephone exchange inaugurated at the York headquarters of the North Eastern Region, British Railways, on May 5, include direct dialling over certain long-distance trunk circuits. At present this service is available on nine York–Leeds trunks, enabling calls to be dialled direct between any two extensions on these two exchanges, but ultimately, when automatic exchanges are installed at other points in the railway communication system, long-distance dialling will be available between all important railway centres in the North Eastern Region. At the opening ceremony, Mr. T. H. Summerson, Chairman of the North Eastern Area Board of British Railways, said that substantial financial savings were anticipated from the gains in time and efficiency which could be realised with the new exchange equipment. This already gave every department and office direct dialling to some 800 extensions, to be increased later to 1200, whereas the old exchange, which had seen twenty-five years' service, had a maximum of only 540 extensions.

The seven-position manual board at York, showing operators using lightweight combined transmitter and receiver headsets of the new G.P.O. standard design (See our April 10 issue, page 588)

The exchange equipment has been manufactured and installed by the Automatic Telephone and Electric Company, Ltd., Strowger Works, Liverpool, and supplied through Communications Systems, Ltd., sales distributor for private telephone equipment and a member of the A.T.E. group. Mr. C. O. Boyse, Managing Director of A.T.E., described the project as noteworthy in that it typified the important trend towards long-distance dialling in current world telephone practice. This exchange was of a type which combined in one installation the features of an automatic internal telephone system with full facilities for outside calls. Inward calls were handled by operators in the usual way, and this, by ensuring the services of an operator for the general public in locating persons or information desired, upheld the principles of " the friendly telephone " to which the G.P.O. was rightly attaching importance. Outward calls, including certain long-distance ones both within and outside the region, could be dialled direct, with important savings in time and labour.

The inaugural call from the exchange was made by Mr. T. H. Summerson to Sir Brian Robertson, Chairman of the British Transport Commission, who was attending a meeting in Brussels. Mr. H. A. Short, General Manager, North Eastern Region, then made a call by direct dialling to the District Goods Superintendent at Leeds.

The seven-position manual board is connected so that trunk demands for a particular district are channelled to a particular section of the board. This is achieved generally by dialling a two-digit code for the district required and then asking the operator for the number in the usual way. Eventually, when the full direct-dialling facilities are available, the caller will dial the two-digit code and the number of the distant extension, to which he will be connected without intervention of an operator at either exchange.

The nine trunks to Leeds already have direct dialling with voice-frequency impulses, as will be used on other trunks when the facilities can be extended. On dialling the Leeds code, the telephone extension is connected to a section of the rack equipment in the York exchange where the d.c. impulses from the dial are converted to a voice frequency by equipment comprising main and standby valve oscillators. This conversion (to 2280c/s in the present instance) is advantageous for long-distance dialling in that pulses can be amplified *en route* if necessary and their shaping can be controlled so that the chances of incorrect actuation of the remote equipment are minimised.

In addition to the voice-frequency dialling trunks to Leeds there are twenty-one other railway trunks. These all operate on a twelve-channel carrier system using channel frequencies between 4 kc/s and 120 kc/s. Valve circuits are used throughout at present, but an experimental transistor channel equipment is being tested between Newcastle signalbox and the signal engineer's office. It is hoped that in the future further trunk channels will be available by the projected microwave link between York, Darlington and Newcastle to which we referred in our January 16, 1959, issue, page 111.

Equipment is also provided at the York exchange for selective ringing over ten railway omnibus circuits. These are accessible from any extension by dialling 60 for connection to the manual board, where the operator then dials the three-digit number of the required outstation. These impulses pass into automatic code-sending equipment which determines from the first one the form of ringing required, and from the last two the code to be sent out. All other dialling is effected by standard three-stage switching. Provision is made in the exchange apparatus for holding an outside call while information is sought from another extension. This facility is available by pressing a button on the telephone instrument.

The power room at the exchange is equipped with two " Cycloc " transformer-rectifier (selenium) units supplied by Harmer and Simmons, Ltd., in which the charging rate is automatically adjusted to the battery condition by static transductor and magnetic amplifier circuits with feedback. In this room, also, is a distribution panel with automatic fault alarm facilities, and adjacent to it is the battery room with two 50V, 400Ah batteries by Pritchett and Gold and E.P.S. Company, Ltd.

Kelvin House

FOR some months there has been a movement towards closer association between the organisations of the Smiths Group, and in order to simplify administration and exchange of information between the companies and combine their competitive resources a co-ordinating board has been set up. The new board will direct the Aviation, Marine and Industrial side of the business, and to satisfy the new arrangements new administrative offices have been built at Wembley. The new building, Kelvin House, occupies a site which at the time of the 1924 exhibition was a lake and gardens, and dominates the approaches to Olympic Way. Our illustration shows that the building, which is of contemporary design, presents a curved glazed façade of seven storeys. The architects were T. P. Bennett and Son, and the building, which rises to a height of 85ft and encloses a floor space of about 50,000 square feet, is carried on 190 bored in-situ piles. Construction is in reinforced concrete with brick panel walls and floors consisting of prestressed ribs and interlocking hollow pot tiles. Tower staircase windows run the full height of the East elevation with relieving panels of blue vitreous enamel, while the pavonazzo marble paved entrance hall is flanked by a mosaic colonnade and the first floor treatment is a silk screened design on plyglass panels. The first to sixth floors are allocated for office accommodation, while on the seventh floor are located the canteen and private dining rooms and kitchens.

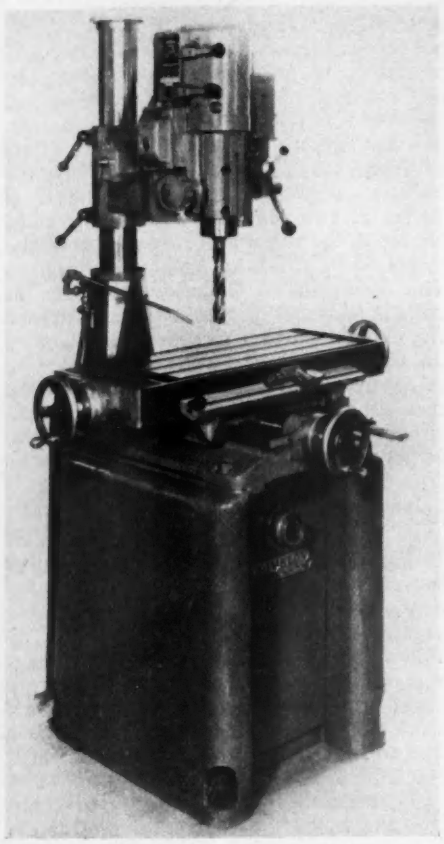
Kelvin House, Wembley

Kelvin House was opened on Monday, May 4, by Sir David Eccles, the President of the Board of Trade, and he was welcomed by Mr. G. B. G. Potter, B.Sc., who explained that a suburban site had been selected for the new offices since it was felt that conditions in the centre of London were likely to become even more congested. Mr. Potter mentioned the complexity of modern industry and the need for co-operation between industry and government, and said that it was only comparatively recently that the six separate companies associated in Kelvin House realised that their businesses were complementary and that since they had to meet strong competition, particularly from overseas, there was much to gain and little to lose by association.

The wide ramifications of the Group's business were illustrated by an exhibition of a selection of products which ranged from electronic equipment, such as precision radar, to gyroscopes and manometric instruments, also flight data systems, hydrograph instruments, autosonic devices and diesel engine protection equipment.

Drilling and Boring Machine

A CO-ORDINATE drilling and boring machine has been developed by Grimston Electric Tools, Ltd., Progress Way, Croydon, Surrey, to supplement the services of a precision jig borer in machine shops. The machine, as can be seen in



Co-ordinate drilling and boring machine with a drilling capacity of 1¼in in mild steel, fitted with a 32in by 12in compound table

the photograph we reproduce, has a box base with a rigid cylindrical column on which the drilling head is vertically adjustable over a height of 14in.

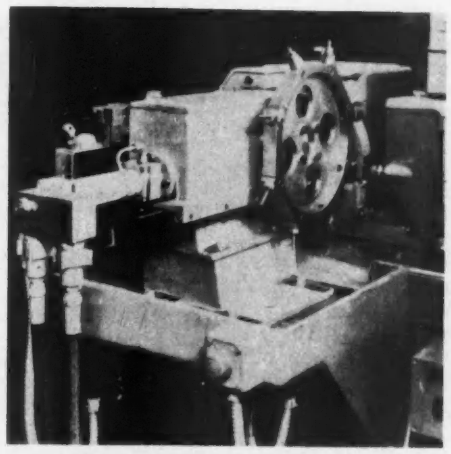
The drilling head, which has a built-in 0·9 h.p. motor, has a capacity of 1¼in in mild steel. Eight spindle speeds from 90 to 1460 r.p.m. are available and four power feeds from 0·0035in to 0·008in per spindle revolution. A depth scale and automatic trip with spring return of the spindle are incorporated.

The compound table has a 32in by 12in working surface and is operated manually over 20in in the longitudinal and 12in in the transverse directions. The handwheels for the table motions are calibrated in 0·001in divisions and, in addition to built-in rules and trays for gauge blocks, dial indicators reading to 0·0005in are fitted for fine table setting purposes.

Centreless Grinder for Drill Bushes

A CONTROLLED-CYCLE No. 0 Wickman-Scrivener centreless grinding machine has been adapted for the automatic grinding of drill bushes on the outer diameter and under the head by Arthur Scrivener, Ltd., Tyburn Road, Birmingham. This machine, illustrated here, is fitted with an eight-station indexing work turret mounted on a slide and actuated by a cylinder.

The bushes are fitted on spindles on the turret and at the commencement of the grinding cycle the piston moves the turret forwards to position



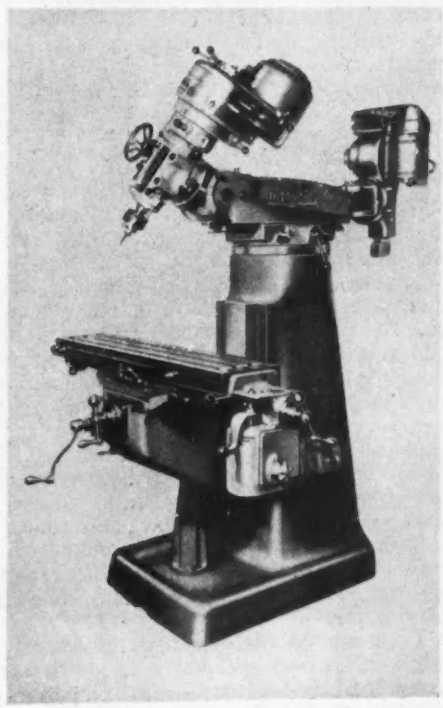
Centreless grinder arranged for automatically grinding drill bushes to outside diameter and under the head

a bush between the grinding wheels which are open. The wheels are then closed to the predetermined grinding size on diameter and they grind under the bush head to the limit set by the turret in-feed. The grinding wheels then open and the turret induces the next piece into position in the throat. Normally the amount of stock removed from a bush is 0·003in and the machine operates on an eight-second cycle. The makers state that, if required, the machine can be supplied with automatic work loading equipment and feed-back size control from an air-gauging head to a micro sizer.

Turret Milling Machines

WE are informed by Adcock and Shipley, Ltd., Ash Street, Leicester, that under an agreement with Bridgeport Machines Inc., of the United States, it is now making "Bridgeport" turret milling machines in this country. These machines, one of which is illustrated below, are of the usual knee and column construction but have a turret mounted on the machined face at the top of the column. A ram adjustable along a slide in the turret base can be fitted with power-operated heads at each end, and the turret can be swivelled to bring either of the heads into the operative position over the machine table.

At one end the ram has a swivel mounting fitted with a worm and wheel to provide angular adjustment in a vertical plane normally parallel



Turret milling machine with a milling head at one end of the ram and slotting attachment at the other

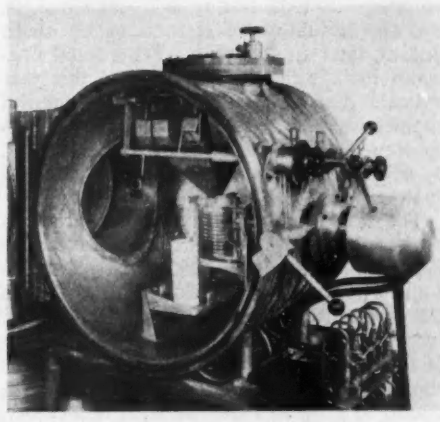
with the table movement. Usually this mounting carries a milling head with a 1 h.p. motor giving eight spindle speeds from 62 to 2265 r.p.m. and three reversible power feeds. The quill has a travel of 5in, and means are provided for rapid lever as well as slow handwheel feed. The head itself can be adjusted in a vertical plane by means of a worm and wheel.

A mounting at the opposite end of the ram can be swivelled in a horizontal plane and can be fitted with a variety of attachments for shaping, slotting, &c. For profile milling purposes a mechanical device can be used, or alternatively a hydraulic attachment incorporating a stylus mounted on a separate turret and a cylinder which moves the knee up and down. For co-ordinate drilling and boring two systems are available, one using length bars and dial indicators and the other optical equipment.

The machines to be made by Adcock and Shipley, Ltd., will have standard 42in by 9in tables, with a 30in longitudinal and a 12in cross traverse, and a vertical movement of 16in. Normally the tables are arranged for hand operation but power feeds can be incorporated if required.

General Purpose Vacuum Furnace

A NEW small general purpose vacuum furnace with resistance or induction heating is now being made under the agreement recently completed between The General Electric Company, Ltd., and Vacuum Industrial Applications. The furnace enables laboratories and small workshops to cover with a single unit a wide range of vacuum heating processes, including sintering



Interior of vacuum furnace, showing induction heating crucible, mould and charging buckets

and outgassing. Internal diameter of the work chamber is 24in, and it is clad with stainless steel to facilitate cleaning and to reduce degassing.

Externally-operated handling gear is fitted for making additions to a melt or for taking temperature measurements, and for tilting the crucible. A window in the top of the chamber enables the progress of a melt to be observed. Internal handling mechanisms can be viewed through a window in the chamber door. Graphite, tantalum, tungsten or molybdenum can be used for the resistance heaters according to the particular process and specified vacuum. With a refractory crucible, temperatures of 1200–1400 deg. Cent. can be achieved, while if a graphite crucible is used it is possible to obtain temperatures up to 1800 deg. Cent.

In the induction heating versions, a 10kW, 10,000 c/s generator is used which will give temperatures in excess of 1700 deg. Cent. in the charge for melting. When sintering, the power is absorbed in a graphite susceptor where temperatures in excess of 2400 deg. Cent. can be achieved.

A two-stage high-speed pumping system is used to evacuate the furnace tank. Short pumping cycles can be used and the furnace will operate satisfactorily in spite of the severe outgassing which may occur with some processes. Vacua of the order of 10-5mm mercury can be obtained. An oil vapour pump and a Kinney rotary pump are used in series, or the rotary pump alone.

Industrial and Labour Notes

Engineering Production and Orders

The Board of Trade has published a set of statistics concerned with the production, deliveries and orders in hand of the mechanical and electrical engineering industries. A scheme for the collection of these statistics was initiated by the Board at the beginning of last year. The statistics have been compiled from returns covering the year 1958 and indicating certain aspects of the situation in the first two months of the present year.

Taking mechanical and electrical goods together, the figures show that for the whole of 1958 production was maintained at the 1957 level. But that was due to recovery in the final quarter of the year, following a lag in output over the first nine months. In the mechanical engineering sector production was less in each quarter of 1958 than in the comparable quarter of 1957 and over the year as a whole was 3 per cent lower than in 1957. In electrical engineering, however, which has been expanding since 1948 about twice as fast as mechanical engineering, there was a production increase of 5 per cent last year. A substantial part of that increase was, of course, accounted for by the expanding production of consumer goods following purchase tax reduction in last year's budget, and the relaxation of restrictions on credit trading later in the year. Provisional estimates for the first two months of this year indicate that production in the mechanical engineering and electrical goods industries continued above the level of a year earlier, by about 4 per cent, though the increase was less marked in February.

The total volume of exports of products of these industries increased by 9 per cent in 1955, by 7 per cent in 1956 and by between 1 and 2 per cent in 1957. In 1958, there was a fall of 4 per cent, but there was evidence of recovery in the figures for the final quarter of the year. As to the orders in hand, the statistics indicate that total order-books ceased to grow in 1956 and since September, 1957, have fallen consistently. If comparison is made with figures for some earlier years, it seems that the volume of orders held at the end of February last was about 10 per cent less than at the end of 1954. About that, the Board of Trade's comment is that smaller order books usually imply shorter delivery and, to that extent, greater competitive power in the world markets. Orders on hand for the home market began to fall in 1956, but export orders did not reach their peak until early in 1957. Since then, the Board of Trade says, home and export orders have fallen in about the same proportion and the latest figures, those for February, provide no evidence of a check to that movement.

International Conference on Materials Handling

The Institute of Materials Handling held its first international conference at the Waldorf Hotel in London last week. Sir Edward Beddington-Behrens said in his speech at the opening of the conference on Wednesday, May 6, that the materials handling industry was primarily aimed at increasing productivity. The Institute was formed in 1952, following the visit of a team to the U.S.A. to study American materials handling techniques, under the auspices of the Anglo-American Council on Productivity. It was a professional Institute of individuals, actively interested and engaged in one aspect or another of materials handling. Ten years ago, Sir Edward stated, the U.S.A. was the spiritual home of the materials handling engineer and the materials handling industry in other countries was largely an attempt to copy American methods. The problem in Europe might not always be adaptation to mass, large-scale production, but more often a matter of finding practical means of reducing costs in medium-sized factories, specialising in quality production. There could be no doubt, Sir Edward added, that the Institute had had a profound effect on the establishment of materials handling as a science and the conception of the materials handling specialist as an engineer in his own right.

The programme of the three-day conference, which included film shows and works visits, was arranged in sixteen seminars, in order to provide opportunity for discussion and argument by the audience.

Training of Air Line Pilots

It has been announced that the facilities at Hamble Aerodrome of Air Service Training, Ltd., have been acquired by the nationalised air line corporations to form a College of Air Training to provide a source of trained pilots such as were formerly available from Royal Air Force Short Service engagements. The Board of Governors will be nominated by the air line corporations and the Ministry of Transport and Civil Aviation : the Ministry of Education, other educational interests and independent air line operators will be represented on the board. The state will contribute £1000 to the cost of training each pupil, and it is estimated that an operator sponsoring a candidate for the two-year course will have to provide approximately £3000 ; this excludes tuition fees and living expenses, although the college will be residential, but it is, we are advised, possible that a grant from the local education authorities may be available to meet these. The intake for the first year will be fifty candidates of about eighteen years of age : in the following four years a maximum of 110 may be accepted.

Overtime and the Shorter Week

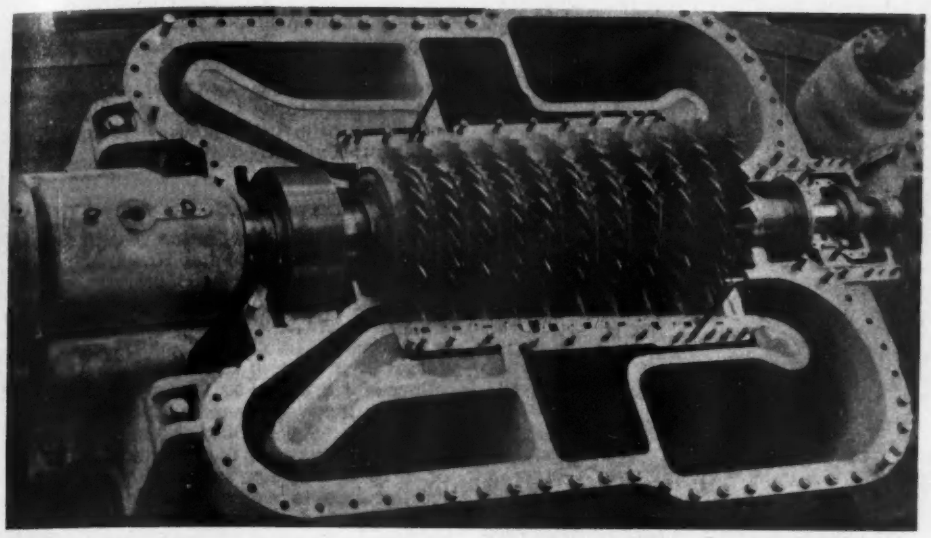
The Engineering and Allied Employers' National Federation has rejected a claim for the revision of the overtime agreement which was put forward by the Confederation of Shipbuilding and Engineering Unions. The unions had asked that overtime should either be eliminated or substantially reduced and added the suggestion that one way of bringing that about would be to increase rates of pay. In their reply, the employers asserted that, however short the working week might become, some overtime would always be necessary. Ultimately, they pointed out, it was neither the unions nor the managements who decided the extent of overtime ; it was determined by customers' requirements. Employers, therefore, must retain the right to decide when overtime working was needed.

Comment on the extent of the working week in industry generally is made in the latest bulletin of the British Employers' Confederation. There it is emphasised that the number of hours worked in a factory, mill or yard is not what a collective agreement lays down as normal working hours. It is governed by the demand for the product and the nature of the process. The bulletin recalls the latest figures which show that, at the end of last October, the average number of hours worked by men in manufacturing industry was over forty-seven a week. Throughout practically the whole of manufacturing industry, standard hours are forty-four or forty-five a week. With expanding demand, the Confederation observes, the actual number of hours worked is unlikely to fall in the immediate future. New and better plant cannot earn its keep by standing idle for more hours a week. A reduction in the standard working week from forty-four to forty hours without loss of pay, the bulletin continues, means an increase of 10 per cent on standard hourly wage rates. On top of the 10 per cent would come similar increases in overtime and premium rates. The Amalgamated Engineering Union, the bulletin adds, has resolved to press both for a rise in basic rates and a reduction of standard hours to forty a week. The first is expressed as an immediate increase of 15 per cent and the second, in the Confederation's view, would be equivalent to a wage increase of 13 per cent.

Industrial Safety

There was a large attendance, numbering approximately 1000 delegates from all branches of industry, at the industrial safety conference at Scarborough, last week-end, organised by the Royal Society for the Prevention of Accidents. The conference was opened by Sir George Barnett, a former Chief Inspector of Factories, who emphasised work now being done in technical schools and colleges to improve standards of safety training. He spoke also about the steps being taken by private industry to ensure that the training of operatives was carried out with a full understanding of the safety requirements of each individual job.

Among the many papers presented at the conference was one by Mr. W. Milton Larke, general manager of Stewarts and Lloyds, Ltd., who spoke about safety organisation in a factory. It was necessary, he said, to create and foster the growth of the right attitude of mind in every individual who made up any human organisation. To do that needed not only unremitting effort, but also imagination and perception. Many processes, Mr. Larke continued, had risks associated with them which were inherent, but he was nevertheless convinced that, by a positive approach to the problem confronting each industry, much could be done in the design of operations and tools to minimise the risks. Safety organisation in a factory and responsibility for accident prevention, Mr. Larke continued, rested with line management, whether general manager or foreman, superintendent or charge-hand. There must be no possible excuse in the organisation for any of those people to be able to say that something or other which ought to have been done was not their job. The role of the safety officer should be purely advisory. The safety officer should be responsible only to the general works manager in the case of a large organisation or to the works manager or managing director in the case of a small company, so that the normal line of command could function in safety as in any other field.



German Industries Fair, Hanover

No. III—(*Continued from page 745, May 8*)

With a hall space totalling 270,000 square metres, and an open area of 140,000 square metres, the German Industries Fair was held at Hanover during the period April 26 to May 5. From small beginnings in 1947, it has developed into the most important technical fair on the European Continent. Although the rate of its physical expansion is now levelling off, its commercial importance is still increasing, as indicated by the growing foreign participation, which rose from 14 per cent in 1958 to nearly 17 per cent this year.

BBC-Krupp Atomic Power Group

A NOVEL approach to the problem of utilising nuclear energy was shown on the stand of Fried. Krupp, Essen, where the whole of the central domed hall of 600 square metres was devoted to various aspects of the high-temperature reactor designed by the Brown, Boveri et Cie/Krupp nuclear working group. The reactor, of which a one-fifth full-scale model was shown (Fig. 12), is laid out for a thermal output of 50MW, equivalent to an electrical capacity of 15MW. A sectional view is shown in Fig. 13. The graphite-moderated core consists of graphite spheres containing a mixture of uranium carbide and graphite, the uranium being 20 per cent enriched with U235. In addition, a certain number of spheres contain thorium for breeding U233. Several thousands of these spheres, measuring about 6cm in diameter, are employed in the core, the reactivity of which has a negative temperature coefficient. Thus the heat output will stabilise itself for any filling height at a definite temperature which depends upon the quantity of spheres in the core and the rate at which heat is being extracted by cooling. Spheres can be added and extracted, and in this way the reactor is controlled.

Cooling is carried out by placing the core and a steam generator (heat exchanger) in series in a closed circuit containing a helium-neon mixture as coolant. Should the gas circulation fail, the core will stabilise itself at a somewhat higher temperature, and thus be inherently safe. Nevertheless, control rods are incorporated for use in a complete shut-down. These rods can be dropped into vertical channels formed inside four graphite ribs which extend into the core from the surrounding graphite reflector.

From the blower at the bottom of the reactor, cooling gas enters the core through holes in the bottom of the moderator and passes through the layer of spheres, where it is heated from 200 deg. to 850 deg. Cent. (since the elements remain mechanically strong at 2000 deg. Cent., the outlet temperature could probably be substantially increased). The heated gas leaves through holes in the graphite lid over the core, and enters a boiler consisting of a number of water, saturated steam, and superheater sections formed as horizontal spiral hairpin sections (Fig. 12, right). Certain of these boiler sections are arranged for direct flow, others for counter-flow, and the large number of parallel sections ensures that tube failures in one or even several sections do not put the plant out of commission. A boiler by-pass is provided. The forced-circulation boiler is designed for conditions at the stop valve of 75 atmospheres and 505 deg. Cent.

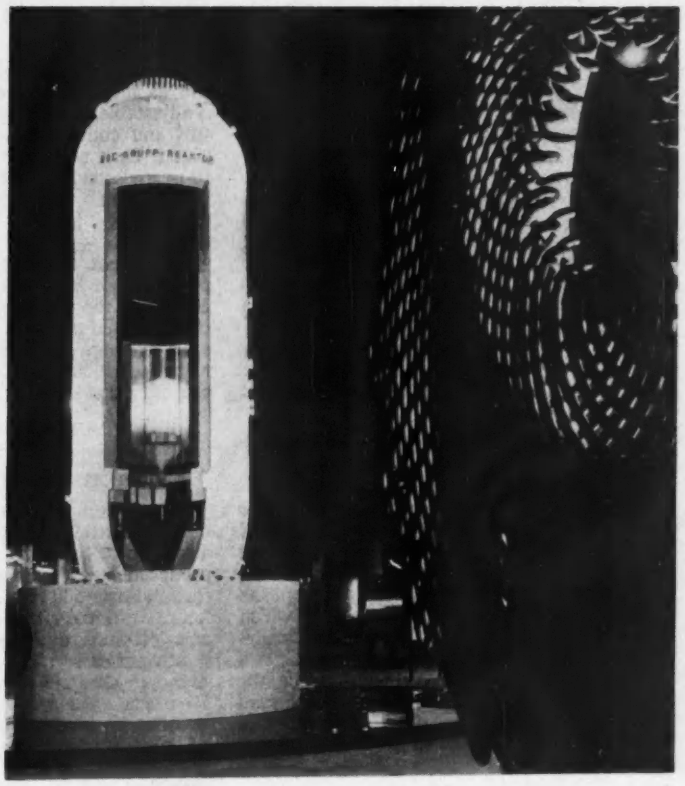
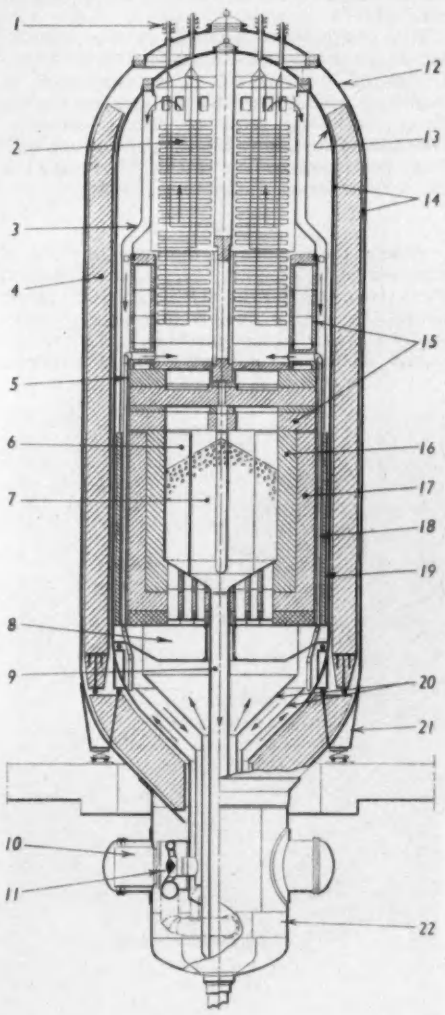


Fig. 12—One-fifth scale model of B.B.C./Krupp high temperature reactor for a thermal output of 50MW, or 15MW electrical. A helium-neon mixture is circulated through a graphite-moderated core of spherical elements (mainly graphite-enclosed uranium carbide) which heats the gas from 200 deg. to 850 deg. Cent. It then passes through the boiler at the top of the reactor vessel (element on right), generating steam at 75 atmospheres, 505 deg. Cent.



1—Steam pipe lead through.
2—Steam generator.
3—Cooling gas ducting sheets.
4—Biological shield.
5—Inlet for fuel spheres.
6—Ribs containing safety rod channels.
7—Core.
8—Supporting spider.
9—Outlet for fuel spheres.
10—Blower motor.
11—Blower.
12—Outer steel shell.
13—Inner steel shell.
14—Barrier space.
15—Carbon filling.
16—Reflector.
17—Carbon block shell.
18—Cooling gas by-pass pipes.
19—Thermal shield.
20—Cooling gas ducting sheets.
21—Supports.
22—Blower shell.

Fig. 13—Section through B.B.C./Krupp high temperature reactor

Although it is envisaged that the fission products will mostly remain enclosed in the spheres—which can be added and extracted for further treatment as required—provision has been made for complete protection even should the system become contaminated. The reactor which is to operate with a gas pressure of the order of 10 atmospheres is enclosed in a double pressure vessel, the hollow walls of which contain the biological shield (barytes concrete) and are maintained at excess pressure to prevent leakages to the outside. Further insulating and shielding layers are situated between the graphite moderator and the inner steel wall of the reactor vessel, with return channels for the cooling gas.

The reactor was ordered by the Arbeitsgemeinschaft Versuchs-Reaktor G.m.b.H. (AVR), Düsseldorf. The AVR is an association of municipal electricity undertakings, at present eleven, including those of Aachen, Bremen, Duisburg, Düsseldorf, Munich, and Wuppertal. Most probably, the new reactor will be sited at the Nuclear Research Centre near Jülich.

Benoto

Among the exhibits on the open-air stand of Etablissements Benoto, 57, Avenue Kléber, Paris (16e), was shown the "SEGBI 160" power shovel (Fig. 14). In this four-wheel hydraulically driven, 160 h.p. machine, the front and shovel section is universally linked with the

Fig. 14—Five-cubic-metre, 160 h.p. power shovel—Benoto

rear and engine section, making for a very small turning radius (5·6m overall) and good adaptation to the terrain. The 5 cubic metre bucket can lift up to 6 tonnes and discharge at a level of approximately 3·3m under the blade, thirty-one to thirty-two seconds being required for the cycle. The machine weighs about 13·5 tonnes and can exert a thrust at the blade of 8 tonnes (horizontal) to 10 tonnes (shovelling).

Schwing

An improved design of a self-erecting tower crane was shown by Friedrich Wilh. Schwing G.m.b.H., Wanne-Eickel, Heerstrasse 11–27. As will be seen from our illustration, Fig. 15, the crane possesses a level-luffing jib anchored to the slewing superstructure well to the back of the tower centre line. The layout enables 1·5 tons to be lifted at 20m to 30m radius, depending upon the crane model ; on the other hand, the load can be brought very close to the mast by derricking the jib, so that obstacles can be cleared. The crane is self-erecting by adding additional telescopic sections at the top of the mast. It can either be erected inside the building and attached to the structure, in which case the mast can climb with the building as construction

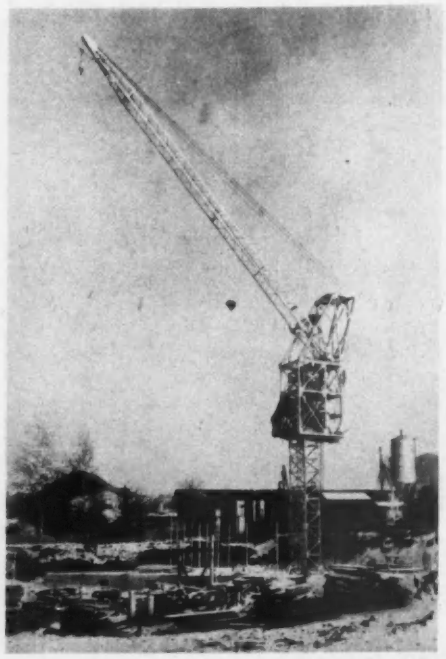


Fig. 15—Self-erecting jib crane—Schwing

proceeds, or else—for heights under the hook of up to 50m—the crane can be mounted on rails. A personnel or materials lift can be fitted inside the mast. (Agent : Greenham Equipments, Ltd., Clayton Road, Ruislip Road, Greenford, Middlesex.)

The same firm introduced a two-cylinder hydraulic concrete pump (Fig. 16) for a maximum delivery of 35 cubic yards per hour. The maximum horizontal and vertical pumping distances are, respectively, 1300ft and 165ft. Operation is by means of oil pressure from a 46 g.p.m., 1120 lb per square inch unit driven by a 52 h.p. electric motor, or a 60 h.p. internal combustion engine. Each working piston of 7¼in bore and 5ft stroke is actuated by two double-acting hydraulic cylinders. By filling

Fig. 16—Two-cylinder hydraulically operated concrete pump—Schwing

the space behind the pumping piston with water light matter is rinsed out, while sand and heavier residues are discharged into a settling tank. A glass window in this tank allows the rate of deposition to be judged. Excess deposits indicate wear of the rubber piston sleeves which then can be quickly replaced. Hydraulically-operated gates connect one pumping cylinder at a time to the concrete delivery pipes, while the other is being charged from the 1½ cubic yard hopper. (Agent : Concrete Equipment and Metal Products (Westminster), Ltd., Orchard House, 14, Great Smith Street, London, S.W.1.)

Mannesmann-Meer

In the pavilion of Mannesmann-Meer A.G., Mönchen-Gladbach, was exhibited a pipe welding transformer with air-cooled primary winding, and a single copper section in the secondary winding which minimises both the voltage and temperature rise. These transformers are built up to the largest sizes used for pipe welding. Another exhibit was a vertical, double-acting oil-less compressor of 135 h.p., with piston rings and glands of a special grade of carbon. This machine is completely dustproof.

Elektro Spezial G.m.b.H.

Five of the measuring instruments introduced by Elektro Spezial G.m.b.H., Hamburg 1, Mönckebergstrasse 7, use printed circuits. They include a broad band oscillograph for 3 c/s to 15 Mc/s, with built-in signal delay of 0·3μ second. Its great brightness gives good images even of steep impulse flanks. A millivoltmeter with a most sensitive range of 0–100μV covers a frequency range of 2 c/s to 2 Mc/s. For the range 1 kc/s to 30 Mc/s a millivoltmeter of similar sensitivity has been produced. The first of its seven amplifier stages is incorporated in the test head to reduce input capacitance and damping. A d.c. millivoltmeter enables direct voltages to be measured from 10μV to 1000V and direct currents from 10^{-12} to 10^{-6}A. The frequency-modulated standard oscillator for

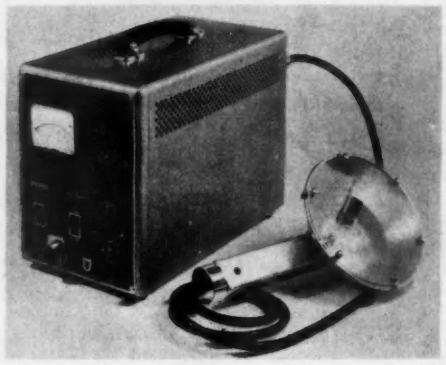


Fig. 17—Electronic stroboscope with flashing rate adjustable between 5 and 300 per second, and a flash duration of 10 microseconds. The phase of the flashes can be varied and measured with accuracy—Elektro Spezial G.m.b.H.

4·5 to 300 Mc/s offers seven modulations, and its output voltage of 0·1μV to 1V (or 140dB) is adjustable in six stages of 20dB, four stages of 4dB and continuously from 0–4dB. We illustrate a flash stroboscope (Fig. 17) which gives 10-microsecond flashes with a repetition frequency of 5 to 300 times per second, accurate, to within ±2 per cent for mains voltage fluctuation up to ±10 per cent, and measurable to ±1 per cent. With fixed synchronisation, the phase of the flash can be set to trail 0 deg. to 345 deg., the accuracy of phase measurement being quoted as better than 5 per cent of full-scale reading. This novel device will be found to be particularly useful for testing such things as the periodic opening and closing of electric contacts.

Gutehoffnungshütte Sterkrade A.G.

Screw compressors, which Gutehoffnungshütte Sterkrade Aktiengesellschaft built originally under Swedish licence, are now being produced by this company in a standard range from about 500 to 27,000 cubic metres per hour, with compression ratios of up to four and pressure differences per stage of up to 8 atmospheres. The largest installations produced to date are five three-stage plants for the Rourkela steel works, each capable of compressing to 15 atmospheres 23,000 cubic metres of raw blast-furnace gas per hour. Screw compressors are stated to be insensitive to dirt deposits, and the fact that the rotors do not require lubrication is of importance, e.g. in the food industry. Suitable for pressure ratios of up to five, and gas flows of 15,000 to 500,000 cubic metres per hour, axial flow compressors (as illustrated at the top of page 781) also from part of the production programme.

Hartmann and Braun

The "Complex Alternating Current Compensator," shown by Hartmann and Braun A.G., Frankfurt/Main, is used in conjunction with a null-indicator (such as the exhibited oscillograph) for precision current measurements in the range 0·005A to 20A and voltage measurements of 0·05V to 500V. In addition, measurements of capacity, inductance, phase angle, can readily be carried out, as well as measurements on machines, such as the resistance of windings, short circuits, stray reactance, the accuracy of measuring transformers, the properties of magnetic materials. The unit is mounted in a portable case. Current and voltage ranges can be extended by means of shunts and series resistances.

Wattmeters have been put on the market in which the power consumption of the voltage coil has been halved. The resulting reduction in thermal load has made it possible to build smaller recorders, such as a three-movement recorder in a housing measuring 288mm by 240mm. In Fig. 18 we illustrate the "GLMv"

Fig. 18—Electro-dynamic voltmeter with light pointer—Hartmann and Braun

electro-dynamic voltmeter with light pointer. This "Class 0·1" instrument measures with the utmost precision r.m.s. low-frequency a.c. as well as d.c. voltages up to 720V. The moving coils are ribbon-suspended and screened by highly-permeable alloy. The double scale is 270mm long and permits direct readings to the limit of accuracy.

The electronic compensating recorders, "Polycomp" and "Linecomp," can now be supplied with interchangeable measurement ranges which can be plugged in or switched in as required. In the C.M.R. system, shown in operation in Hanover, a wide variety of physical measurements, such as occur in industrial processes, can be converted into electrical quantities, integrated over a time interval and finally numerically recorded by means of an electric typewriter. For Schering bridge measurements on high-tension equipment, it is no longer necessary to maintain the bridge at the high potential with the consequent need for remote control. Ancillary equipment makes it possible to leave the bridge at a low potential and compensate for errors arising from stray capacitance. A twin-chamber version of the "Magnos" oxygen analyser has been produced which uses the well-known "magnetic wind" principle in a differential arrangement for flue gas analysis. Alternatively, the two cells may be used in series to double the accuracy of absolute measurements.

Leybold

The firms, E. Leybold's Nachfolger and Leybold - Hochvakuum - Anlagen G.m.b.H., Cologne-Bayenthal, Bonner Strasse 504, showed a vacuum gauge covering the two ranges 70–1mm Hg and $1–5\times10^{-3}$mm Hg. The "Thermotron II" is a hot-filament (Pirani) gauge in which the heat loss is automatically compensated, so that the filament is maintained at constant temperature, and is thereby protected from ageing. The heat loss is measured and indicates the vacuum. An output voltage of 10V can be used for operating a recorder or vacustat. There are only two control switches, one for the range, the other for three measuring positions.

An ionisation gauge for 10^{-2}mm to 10^{-8}mm Hg (readings to 10^{-9}mm Hg) is equipped with a modified Alpert valve and is insensitive to air leaks. Zero drift and heater current variations are so small that only the latter has to be adjusted once, when a new valve is fitted. A recorder or vacustat can be connected to the 10V output.

August Oppold, Oberkochen

Dynamically balanced and magnetically crack-tested cutters and routers were demonstrated by the firm August Oppold, Oberkochen/Württemberg. Fig. 19 shows an example of combination cutter, with interchangeable, adjustable blades,

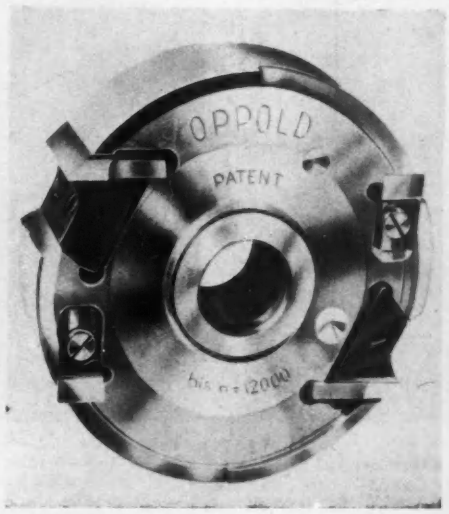


Fig. 19—Four-bladed cutter head for speeds up to 12,000 r.p.m. Interchangeable and adjustable tungsten carbide or high-speed steel cutters can be used —August Oppold

for speeds up to 12,000 r.p.m. Either high-speed steel or tungsten carbide cutters can be used; the latter are claimed to have two or three times the endurance previously known for carbide, owing to a special grinding method. Compared with high-speed steel, the endurance is up to seventy times greater, depending on the kind of wood.

Martin Miller

Improved performance, cleaner cutting, and reduced power consumption are claimed by Martin Miller A.G., Vienna VI, Webgasse 26, for its taper section band saws. The (broader) front edge can be heat-treated before cutting the teeth, eliminating the danger of cracks and fracture. Sharpening can still be done with a file. The band saws are supplied in widths ranging from 12mm to 35mm, with cutting widths of 0·6mm to 0·8mm (mean widths of blades 0·45mm to 0·50mm).

Feldmuhle Sudplastik und-Keramik

Further improvements in the quality of its sintered aluminium oxide cutting tools was shown by Feldmühle Südplastik und-Keramik G.m.b.H., Plochingen/Neckar; this firm showed the taking of finishing cuts on a cast iron workpiece at 260m per minute, a cutting depth of 0·1mm, and a feed of 0·035mm per revolution. A finish of 7·5 microns (Perth-O-Meter measurement) is stated to be obtained.

Albert Fezer

For transporting plates and sheets of steel, wood, glass, plastic and rubber, &c., Albert Fezer Maschinenfabrik G.m.b.H., Esslingen/Neckar-Zell, has developed a lifting tackle using suction pads, and incorporating a vacuum pump and vacuum container. The latter can also be mounted separately. One application shown was the packing of television sets into cardboard boxes, the cotton dust cover preventing any mark being left by the suction pads on the polish. The United Kingdom agent is Interwood, 326, Finsbury Pavement, London, E.C.1.

A.C.E.C.

Ateliers de Constructions Electriques de Charleroi, Belgium, showed a 100 kg capacity induction melting furnace, together with its supply unit; a vertical rotary frequency changer (motor generator set), transforming the three-phase, 50 c/s mains current into single-phase current at 2000 c/s. The output is 120kW, and the whole installation operates automatically. Besides a range of small motors from its plant at Brussels-Ruysbroek, the company showed nuclear equipment, the model of a transfer machine for automobile components, magnetic recorders, and household appliances. The "SGX A–2" recording spectrometer, shown in operation, allows the automatic recording of gamma and X radiations by conversion into

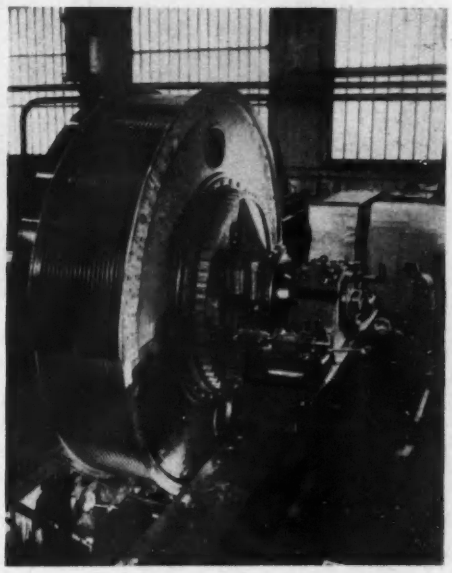


Fig. 20—Pulley for a 987-ton per hour inclined skip hoist for opencast ore mine. The 21-ton capacity skips move on a 481m long, 40 deg. incline—A.C.E.C.

electric impulses of varying amplitude, by means of a thallium activated crystal of sodium iodide where the maximum energy is above 100 keV, and by a proportional counter where it is less. Printed circuits are widely used in a scaler, precision ratemeter and scintillation counter, shown in the form of a counting installation for alpha, beta and gamma rays. The precision ratemeter is stated to have a resolution lower than 1 microsecond and linearity better than 1 per cent on all ranges from 5 to 100,000 impulses per second at full scale. It does not require zero setting or preliminary warming up, and has a stability of better than 1 per cent over several days.

Shown as a working model was a winding machine for a 1000ft deep, 1600ft long, skip hoist for an opencast ore mine. Each skip weighs 50 tons fully laden with 21 tons useful load. Hourly capacity is stated to be 987 tons of ore. Our illustration, Fig. 20, shows the winder pulley during works assembly. The machine is controlled by means of magnetic amplifiers.

Otto Suhner G.m.b.H.

A flexible shaft drive made in two sizes (2·5 h.p. and 3·5 h.p.) has been put on the market by Otto Suhner G.m.b.H., Säckingen/Baden. Powered by a totally enclosed, externally ventilated three-phase squirrel-cage motor, its speed is steplessly variable from 1200 to 10,000 r.p.m. on the intermediate, and 5500 to 40,000 r.p.m. on the final output shaft.

GEBR. CANALI

A selection of band saws from the production programme of Gebr. Canali, Speyer/Rhine, included the machine illustrated in Fig. 21. Its cutting height is hydraulically adjusted, using as pistons the frame columns, which move inside the column stands. In the left stand is incorporated the pump unit, in the stand on the right the control mechanism, which provides an automatic offset of the blade but can be cut out for reversing the carriage during the cutting stroke. The feed is hydraulic and infinitely variable. The machine shown has a width between columns of 6ft 6¼in, and uses feeds of 3ft to 100ft per minute and linear saw speeds of approximately 90ft to 110ft per second. Power consumption is about 80 h.p. to 100 h.p., and the standard cutting length 19ft 8in. Tension of the saw blade is maintained by means of a lever and sliding weight.

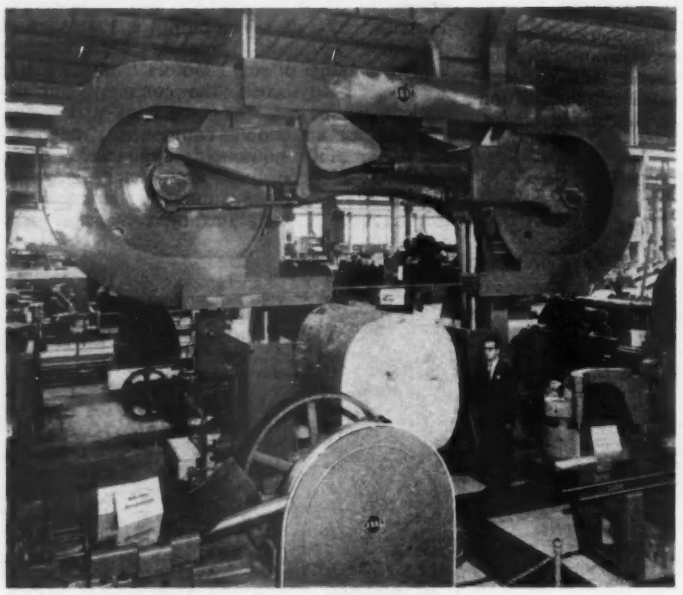


Fig. 21—Heavy horizontal band saw with hydraulic adjustment and feed, equipped with programme control—Gebr. Canali

DEMAG ZUG G.M.B.H.

On the main Demag stand, the Company's subsidiary, Demag Zug G.m.b.H., Wetter/Ruhr, showed a single-girder travelling crane now in series production, which has a capacity of 3 tons with a span of 7m, and can be supplied for span up to 12m and 5 tons capacity. The crab runs suspended from the lower flange of the girder and is electrically driven and controlled from a pendant push-button panel. Travelling speed of the crane is up to 20m per minute, of the crab 18m per minute, and the hoist speed is 7m per minute.

Another travelling crane, also with a capacity of 3 tons, can be used with the crab suspended from a twin-girder traversing bridge or the crab can be run on to an overhead track of corresponding gauge. The arrangement was demonstrated at the fair with the crane controlled either from the cab which forms part of the crab, or by wireless from the ground. It is possible to turn the hoist through ±90 deg. about a vertical axis which is of assistance when handling long loads or where the load must be accurately set down on a base, as in assembly work. Two lifting speeds, 1·2m and 9·5m per minute are provided, also two travelling speeds for the crane and crab, viz. 8m and 33m per minute. The crane bridge and track rails are made from wear-resisting special profiles, and interlocks are fitted to prevent derailments.

G.E.C.

Progress in the design of silicon rectifiers was exemplified at the stand of The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, by a very compact installation designed to handle 2700A at 75V. The twenty-four rectifier diodes were water cooled, together with the busbars, and protected individually by fuses, as well as against water failure, excessive rise in water temperature, diode failure, and failure of the auxiliary current supply.

E.M.I.

The closed circuit television equipment Mark VI, which was exhibited on the stand of E.M.I. Electronics, Ltd., Hayes, Middlesex, has remote-controlled camera movement in both the horizontal and vertical directions, as well as focus and lens selection. A wide-band oscilloscope, the "WM16," has a range of band widths from direct current to 40 Mc/s, a sensitivity of 50mV per centimetre, and a sweep delay of 1 microsecond to 150 milliseconds. The "model 6" industrial stroboscope has an ultra-high intensity Xenon discharge tube and a rate of up to 60,000 flashes per minute.

ZAHNRADFABRIK FRIEDRICHSHAFEN

Our illustration (Fig. 23) shows an eight-step gear transmission which is combined with an SSW driving motor into a compact power unit for use in machine tool drives. The gearbox contains three planetary stages with two electro-magnetic disc couplings in each. One of the couplings acts as a stationary brake. Gear-changing is accomplished during operation of the machine tool by combining in various ways three couplings at a time. In addition, there is a braked and a freewheel position, in both of which the motor continues to run.

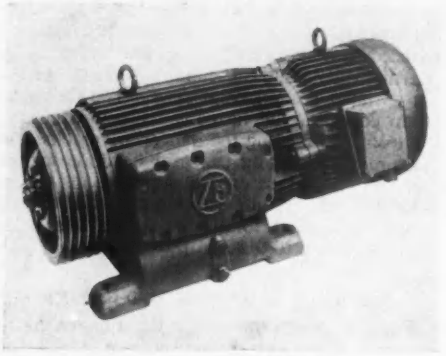


Fig. 23—Machine tool drive with flange motor and eight-step planetary gearbox, operated by electro-magnetic disc clutches—Zahnradfabrik Friedrichshafen

RHEINSTAHL HANOMAG A.G.

A comprehensive and varied programme of tractors and earth-moving equipment was exhibited by Rheinstahl Hanomag A.G., Hanover-Linden. Considerations of space prevent more than brief reference to the main developments, which included the "K65" track-laying tractor, with various bulldozer and grader attachments, and as front loaders and combined front and overhead loaders. The "K90" tractor was shown equipped with side derrick crane, with a boom up to 18m long. In Fig. 22 we show the "B70AF" wheeled front loader, powered by a 70 h.p. two-cylinder, two-stroke diesel and equipped with torque converter, four-speed gearbox, hydraulic clutch and "ZF" power steering. The four-wheel drive goes through planetary reduction gears in the hubs. The shovel holds 0·8 to 1 cubic metre. Thanks to a top speed of 40km per hour, the vehicle can be used on the autobahn.

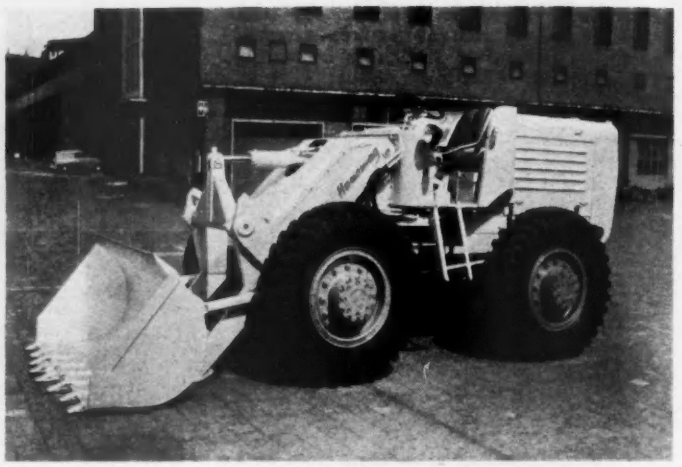


Fig. 22—0·8—1 cubic metre, 70 h.p. all-wheel hydraulic front loader. The wheel hubs are fitted with planetary reduction gears—Hanomag

DEUTSCHE WAGGON-UND MASCHINENFABRIKEN

For testing materials and equipment under varying temperatures and relative moisture, Deutsche Waggon-und Maschinenfabriken G.m.b.H., Berlin-Borsigwalde, Eichborndamm 129-139, showed two laboratory cabinets of 250 litres and 500 litres useful capacity, which allow temperatures to be adjusted between −70 deg. and +100 deg. Cent. Relative humidity is stated to be adjustable over the temperature range +10 deg. to +80 deg. Cent., the highest value being about 15 per cent, the lowest depending upon the temperature and reading about 25 per cent at 20 deg. Cent. The tests are programme-controlled. In addition to built-in recording and indicating equipment, lead-through connections are provided for additional measuring points. The internal lining is of sea-water resisting aluminium alloy and is welded.

SCHIESS-DEFRIES HEBEZEUG-UND KRANBAU G.m.b.H.

On the stand of Schiess-Defries Hebezeug-und Kranbau G.m.b.H., Düsseldorf-Oberkassel, was shown a hand-operated winch for lifting, hauling and erection. In this design the pawl and ratchet are replaced by a non-reversible brake crank as the main brake, in conformity with the latest German safety regulation. The winch is made entirely of steel, without protruding brake levers. An auxiliary, pedal-operated brake on the drum serves to lower the hook if not under load. A three-tooth safety pawl meshing with the drum gearwheel is provided for extra safety. It is disengaged during normal working. All winches of this range are furnished with change gear for two speeds, with the crank turning in the same sense for either speed. The completely enclosed crank brake cannot be tampered with. It operates without backlash whether a single crank or two cranks are being used. At full load the effort at each crank is only 15 kg to 25 kg.

(To be continued)

American Nuclear Engineering Conference

No. I

The fifth Nuclear Engineering and Science Conference was held at the Public Auditorium in Cleveland, Ohio, from April 5 to 10, in conjunction with the 1959 " Atomfair " exhibition. The conference was organised under the sponsorship of the Engineers Joint Council in co-operation with twenty-seven American and Canadian engineering institutions. The exhibition was sponsored by the Atomic Industrial Forum and presented a comprehensive picture of the current state of development in the application of atomic energy in American industry.

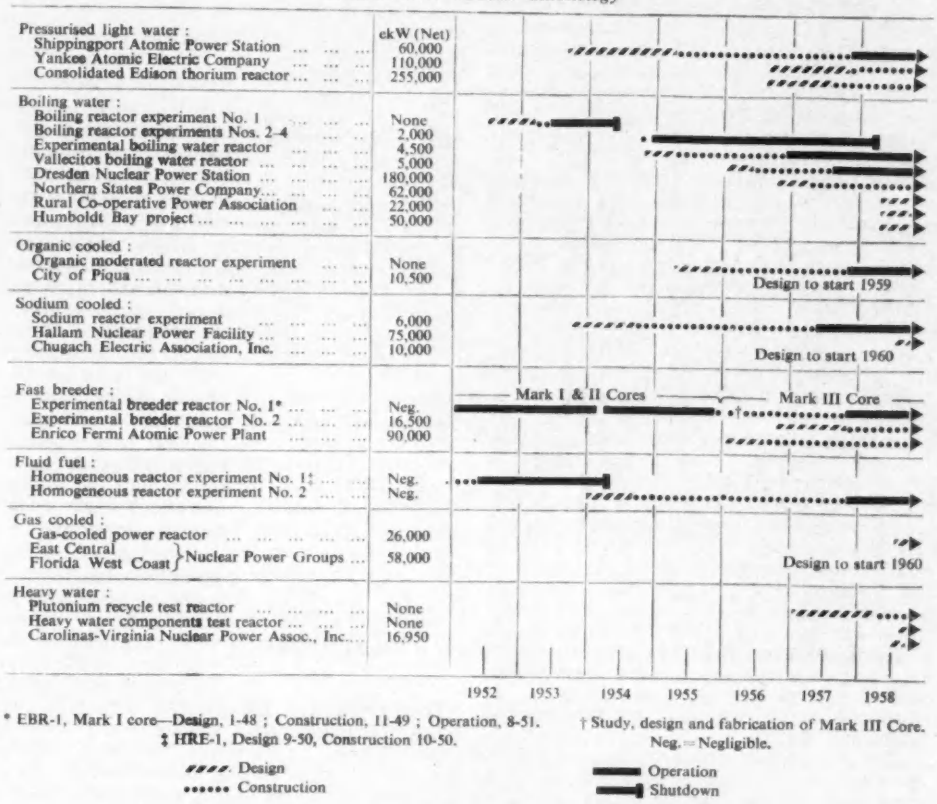
THE year 1959 has been described as a crucial one for the atomic industry in the United States. It is a year when some important decisions must be made, both by Government and industry, and some decisive actions taken in order to realise the yet vastly undeveloped benefits that are certain to be derived from the atom. The 1959 Nuclear Engineering Conference provided an excellent forum for the exchange of the knowledge, information and ideas on which decisions should be based. The number of papers submitted for presentation at the conference, the great number and calibre of industrial concerns participating in the exhibition of products and services, and the large attendance by individual scientists and engineers, reflect the interest and hope for an early development of benefits in the atomic field. If anything was different from past meetings, it was the attitude of those participating. The initial enthusiasm has been replaced by a judicious optimism brought about by constant reminders of costs, and as yet unrealised profits. The peril in this is the tendency to be indecisive, to remain standing still, and to fail to venture beyond what are often unrealistic self-imposed limits, in areas ranging from technical capabilities to markets for products and services.

During the period of almost five years since the passage of the U.S. Atomic Energy Act of 1954, the private American atomic energy industry has developed rapidly. Federal contracts are an important factor for many private companies in the industry—a situation not unique to atomic energy—but there has been a steady growth of a foreign market for power and research reactors, and domestic plans for research, testing and power reactors are impressive. Power reactors are being designed and built for the electric utilities ; materials and components for all kinds of reactors are being provided by private concerns ; some services are being supplied ; and research and development activities in these fields are growing. Three parts of the atomic energy industry, established in the early days of the Federal programme, have continued their growth during recent years. They are the companies which produce and market radiation detection and measurement instruments ; those which process and market isotopes and isotope devices ; and the miners and millers of uranium ores. The industry as a whole obviously still is in its infancy, but estimates are that, during 1959, private outlays for civilian power reactors, for example, were about a third of the national total.

Progress in Power Reactors

During 1958, six civilian nuclear power stations were being built in the United States, in addition to the power plant for the N.S. " Savannah " and two power reactors for export. Two additional contracts were signed for the co-operative industry-Government development of power reactors ; six reactors now are under contract in this joint programme. Three other proposed co-operative contract arrangements for reactors were being negotiated and one other had been proposed. Two other nuclear power stations were under construction and one other being designed, wholly financed by private firms. Work continued at both Government and private facilities to advance the technology of various nuclear reactor systems. Six Federal and one private experimental reactors were operating or being built at the end of the year. The steadily increasing scope of the programme is indicated by the accompanying chart (Fig. 1) which shows the chronology of development of reactor projects already undertaken.

Civilian Power Reactor Chronology



* EBR-1, Mark I core—Design, 1-48 ; Construction, 11-49 ; Operation, 8-51. † Study, design and fabrication of Mark III Core.
‡ HRE-1, Design 9-50, Construction 10-50. Neg. = Negligible.

Fig. 1—Chronology of current American civilian atomic power reactor projects

Pressurised Water Reactors

In the pressurised water reactor concept, fission heat is removed from the reactor core by water pressurised at about 2000 lb per square inch to keep it from boiling. Steam is generated in a neat exchanger through which the pressurised water passes. Experience has demonstrated that this reactor is quite stable and can adjust to large and sudden changes in power load. Its operation does not result in unmanageable radioactivity problems. The primary disadvantages of the system are its low plant heat rate due to the saturation steam pressure and the temperature drop through the primary loop heat exchanger, the necessity for an intermediate heat exchanger, the heavy shielding required over the primary coolant loop equipment, and the high cost of the reactor pressure vessel and primary loop components. Much of the existing technology regarding pressurised water reactors stems from the development of the propulsion plant for the submarine U.S.S. " Nautilus."

The Shippingport Atomic Power Station, which was built as a part of the U.S. Atomic Energy Commission's experimental programme, went critical in December, 1957, and was dedicated in May, 1958, as the first large-scale (60,000 ekW) nuclear power generating station in the United States. During 1958 the Shippingport plant completed two full power tests, each of 1000 hours duration. These runs provided valuable data on core life, primary coolant chemistry, and primary plant radioactivity levels. On November 22, 1958, a routine inspection of the moisture separator on the main turbine revealed a failure of the first stage separator. The separator is a part of the turbo-generator unit and is used to remove moisture from the steam as it passes from the high-pressure section to the low-pressure section of the turbine. Its failure was in no way connected with the nuclear plant. As of December 31, 1958, the plant had delivered a total of 156,500,000 net kWh of electricity to the Duquesne grid.

Further development of large-scale pressurised water systems is being undertaken in the privately financed plant of the Consolidated Edison Company at Indian Point near Buchanan, New York, and the plant being built by the Yankee Atomic Electric Company at Rowe, Massachusetts. The Yankee power station was the first one to be contracted for under the Commission's Power Demonstration Reactor Programme of industry-government co-operation. The core of the Consolidated Edison reactor is being built by Babcock and Wilcox and will contain highly enriched uranium mixed with thorium. Operation will transmute some of the thorium into fissionable uranium 233 which will then supplement the original fuel loading. Obtaining supplementary energy from an oil-fired superheater, the plant will have a total capacity of 255,000 net ekW. Construction began late in January, 1958 (Fig. 2) and completion is scheduled for 1960. The Yankee power station (Fig. 3) is designed to have an initial capacity of 110,000 net ekW. It will employ slightly enriched uranium fuel elements clad with stainless steel. The Westinghouse Electric Corporation is responsible for design and developmental work and Stone and Webster Engineering Corporation for construction.

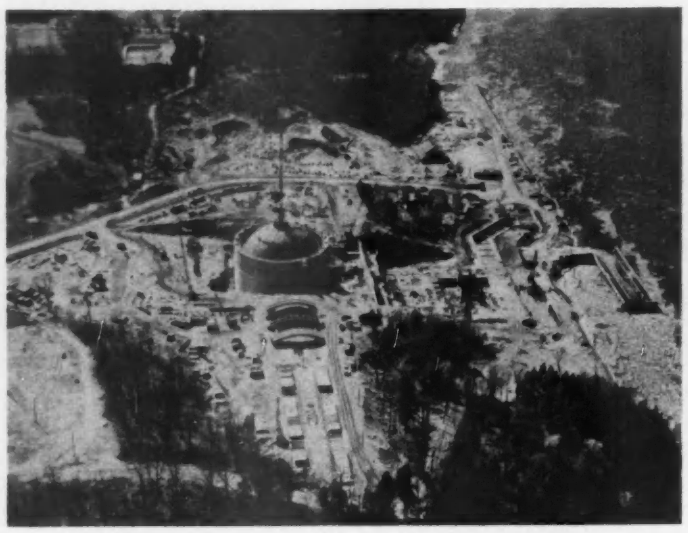


Fig. 2—Current construction progress at the Indian Point atomic power station of the Consolidated Edison Company near New York

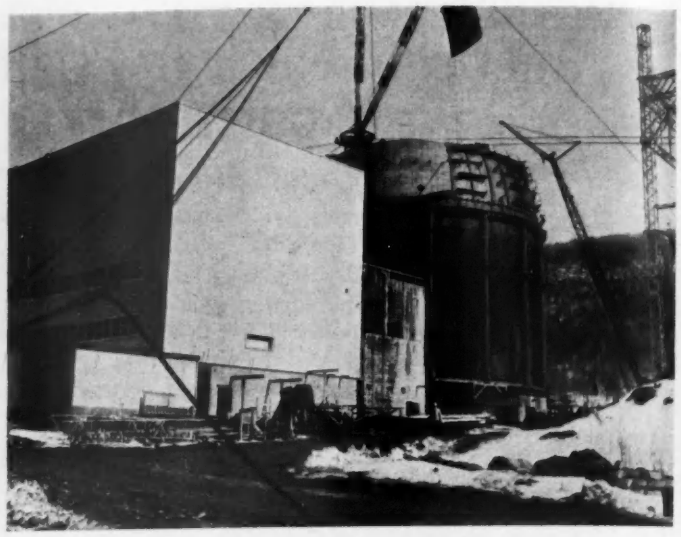


Fig. 3—Current construction progress at the Rowe atomic power station of the Yankee Atomic Electric Company in Massachusetts

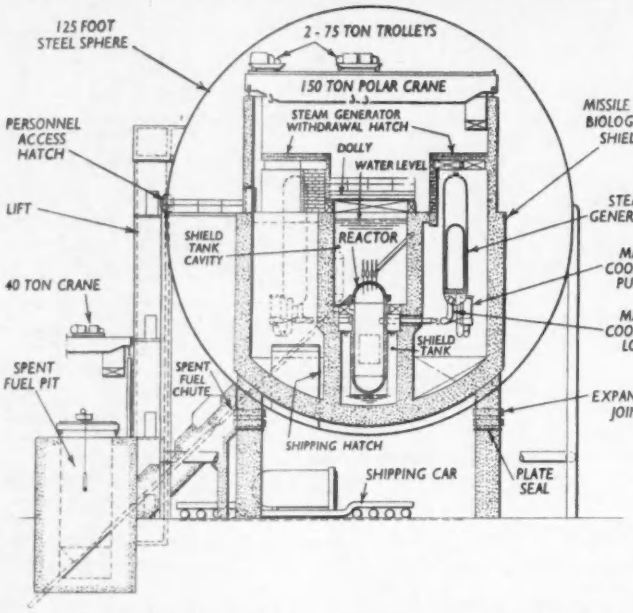


Fig. 4—Sectional elevation of primary reactor system of 110eMW Yankee atomic power station

Construction was about 12 per cent complete at the end of 1958.

The water-filled reactor pressure vessel will be about 9ft in diameter and 30ft high. Its steel walls will be over 8in thick. Inside the vessel will be three stainless steel drums which act as thermal shields. Outside the pressure vessel wall is additional radiation shielding consisting of a water-filled thermal shield tank and approximately 8ft of concrete wall (Fig. 4). The core consists of four similar quadrants, each containing nineteen fuel assemblies. These assemblies will be made up of over 20,000 stainless steel tubes. The 8ft-long pencil-sized tubes are arranged vertically. Each one is filled with about 150 pellets of slightly enriched uranium oxide. Some twenty-four control rods will be arranged to move up or down inside the pattern of tube assemblies to control the neutron reaction in the core.

In December, the A.E.C. signed a contract with the Stone and Webster Engineering Corporation who in collaboration with Combustion Engineering, Incorporated, will carry out an engineering study to develop the design which would lead to the most economical nuclear power station using a pressurised water reactor. The company was selected from among twenty-six which made proposals in response to an invitation issued by the Commission on September 15, 1958.

Boiling Water Reactors

In a direct cycle boiling water reactor, water boils in the reactor core, forming saturated steam which flows directly to a turbine. This system makes possible a relatively simple design with advantages in performance and low costs. For most boiling water reactors no intermediate heat exchanger is used to transfer heat from the coolant to another medium, and in such a direct cycle system, the temperature at the turbine throttle is essentially the same as the reactor outlet temperature. Initially, designers thought that boiling might introduce instabilities into the reactor operations which would limit the power and impair the safety of boiling water reactors. These problems have failed to materialise in experiments conducted by the Argonne National Laboratory in the four Boiling Reactor Experiments (BORAX 1–4) and the Experimental Boiling Water Reactor (EBWR), and by The General Electric Company in the Vallecitos Boiling Water Reactor. It is believed that larger boiling water reactor plants will operate similarly but this has not yet been demonstrated.

BORAX-1 was constructed in 1953 to demonstrate the feasibility of boiling water reactors. The facility was deliberately destroyed in July, 1954, to determine its inherent safety under extreme conditions. BORAX-2 was constructed late in 1954 for further tests, new core combinations were tried using varying enrichments of uranium 235 in the metal fuel plates, and the power level was 6tMW. BORAX-3, operated in 1955, was designed for 15tMW and with a 2000ekW turbo-generator to investigate the use of boiling water reactors for generating electric power. BORAX-4, the most recent of this series, operated from December, 1956, until it was shut down in June, 1958. This reactor was designed for 20tMW and was used principally to test high thermal capacity fuel elements made from mixed oxides of uranium and thorium. These elements have the advantage over metallic elements that they do not become distorted under intense radiation, and, in the event of a failure of protective cladding, are much less reactive with water. BORAX-4 was operated satisfactorily with several experimental defective fuel elements in the core. All the BORAX facilities were operated at the National Reactor Testing Station under the direction of the Argonne National Laboratory.

A new 30,000tMW version of the BORAX facility, BORAX-5, is planned to investigate the practicability of using nuclear power to superheat reactor-produced steam. It would make reactor tests of the best fuel element design for a full-scale boiling and superheating core. Such a core might then be built and BORAX-5 operated as a demonstration reactor to investigate the potential advantages of nuclear superheat in lowering power generation costs. Based on the results of the earlier BORAX experiments, the Argonne National Laboratory placed in operation late in 1956 at Lemont, Illinois, the Experimental Boiling Water Reactor

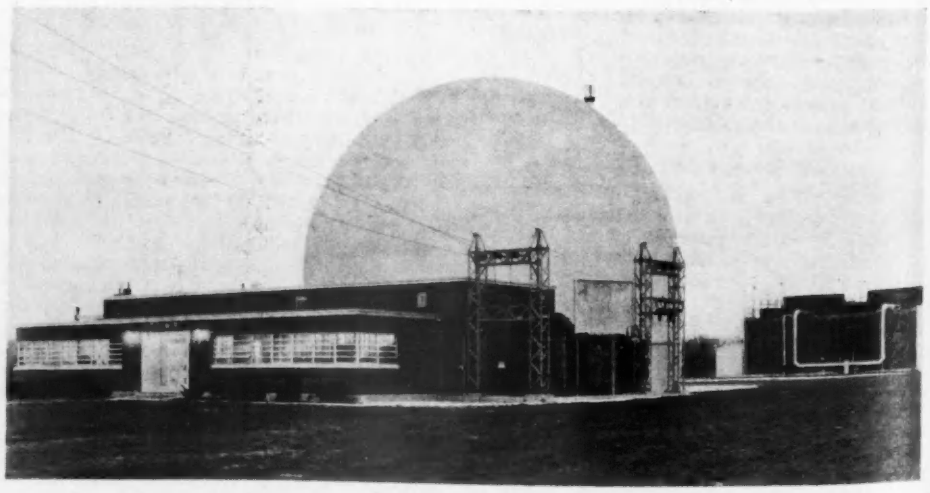


Fig. 5—20tMW Experimental Boiling Water Reactor at the Argonne National Laboratory in Lemont, Illinois

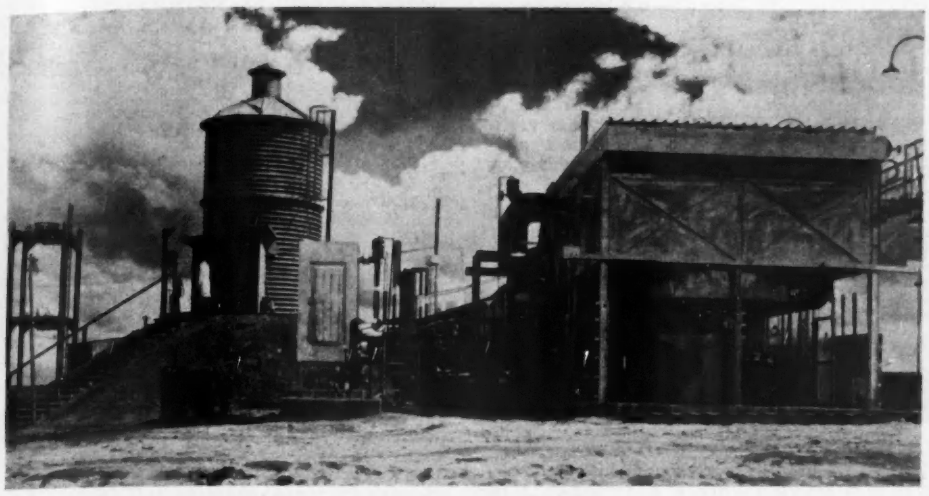


Fig. 6—5eMW Vellecitos boiling water reactor of the General Electric Company at Pleasanton, California

(EBWR) (Fig. 5). The EBWR was designed for 20tMW. It has been operated stably at 61·7tMW without change in the number of fuel elements. The large increase in power was possible because natural circulation of water in the core proved much greater than believed possible, and because, contrary to expectation, the reactor operated stably despite the increased amount of steam in the reactor core caused by high power operation. As of November 30, 1958, the EBWR had produced more than 27,000,000kWh of electrical power from its turbo-generator rated at 5000ekW. The firm of Sargent and Lundy has now been awarded a contract to design the equipment required for converting the EBWR to a 100tMW plant, and Argonne engineers are designing a modified core. Other changes will include the installation of new heat exchangers and the construction of heat removal equipment and a new cooling tower. No additional electrical generating capacity will be provided, but the additional heat will provide steam for the laboratory's central heating system.

At about the time that the experimental boiling water reactor design was completed, The General Electric Company independently designed its Vallecitos Boiling Water Reactor (VBWR) based partially on BORAX experience (Fig. 6). This reactor, which went into operation in 1957 near Pleasanton, California, develops some 5000ekW which is fed into the Pacific Gas and Electric Company grid. Test results have indicated that the power level of this reactor also can be substantially increased without instability. The VBWR is currently operating to provide engineering data on fuels and concepts in support of the 180,000ekW reactor which General Electric has designed for the Commonwealth Edison Company of Chicago, Illinois. The Commonwealth plant is known as the Dresden Nuclear Power Station and is under construction some 40 miles south-west of Chicago near Joliet and was 60 per cent complete at the end of the year.

The Dresden Station (Fig. 7) will have a dual-cycle boiling water reactor. The steam-water mixture produced in the reactor core will flow from the reactor vessel to a primary steam drum essentially at reactor pressure of 1000 lb per square inch. Steam then flows to the turbine through the primary steam lines while the water is fed to secondary steam generators, where additional energy is removed to produce steam at a 500 lb per square inch pressure. This secondary steam flows to a lower stage of the turbine.

General Electric also has completed preliminary design for the Pacific Gas and Electric Company of a 50,000ekW natural circulation, uranium oxide-fuelled boiling water reactor and associated equipment to be built at Humboldt Bay, California. This plant is scheduled for operation in 1962 and is expected to establish the limits of performance for natural circulation, high power density, boiling water reactors.

Under the Commission's Power Demonstration Reactor Programme, a 22,000ekW boiling water plant is being designed by A.C.F. Industries, Incorporated, for the Rural Co-operative Power Association, at Elk River, Minnesota. The plant will use a light-water-moderated, urania-thoria-fuelled reactor in series with a fossil-fuelled superheater. It will employ an indirect cycle, i.e. it will use an intermediate heat exchanger and reactor steam will not go directly to the turbine. It will provide comparison with boiling water reactors using a direct cycle and with those using only urania fuels.

Organic Cooled Reactors

The organic reactor concept involves the use of organic fluids for cooling and possibly for moderating, reflecting and shielding nuclear reactors. One major advantage of organic-cooled reactors is that they can produce fairly high steam temperatures at relatively low reactor pressures. Organic material does not cause corrosion problems and does not become highly radioactive in the reactor. These factors may contribute to a reduction in capital costs. A major disadvantage is the relatively low heat transfer properties of the organic material and the low specific power of such reactors. The tendency of organic coolants to decompose and polymerise under irradiation is also an economic disadvantage.

The Organic Moderated Reactor Experiment (OMRE) at the National Reactor Testing Station in Idaho was built by Atomics International, a division of North American Aviation, Incorporated, and achieved full power in February, 1958 (Fig. 8). This reactor utilises terphenyl as both moderator and coolant and is designed to produce 5MW to 15MW of heat. During 1958 the OMRE was operated with increasing concentrations of radiation-polymerised organic material in the coolant system. It was found that the heat transfer properties of the coolant remained essentially constant until the concentration of the polymerised organic approached 40 per cent, when a significant drop occurred. Two fuel elements of the type to be used in the Piqua power reactor were irradiated in the OMRE in 1958. Both elements failed. These failures apparently were due to some plugging and consequent overheating resulting from the trapping of particulate impurities from the coolant in the small coolant flow passages of the test elements. It is believed that the removal of particulate matter from the coolant will enable this kind of element to operate satisfactorily. The reactor was shut down in October and also in November for the separate removal of the two test elements.

The City of Piqua, Ohio, in response to the Commission's second general invitation under the Power Demonstration Reactor Programme, proposed a 10,500 net ekW organic cooled and moderated reactor to supply steam for use in its municipal power station. This proposal was accepted as a basis for contract negotiations in September, 1956. The Commission has negotiated a contract with the City of Piqua for the operation of the reactor but, with the concurrence of the city government, has withheld its final execution, pending review of safety aspects by the Advisory Committee on Reactor Safeguards. Contract negotiations with Atomics International for the design and construction of the reactor are in progress.

(*To be continued*)

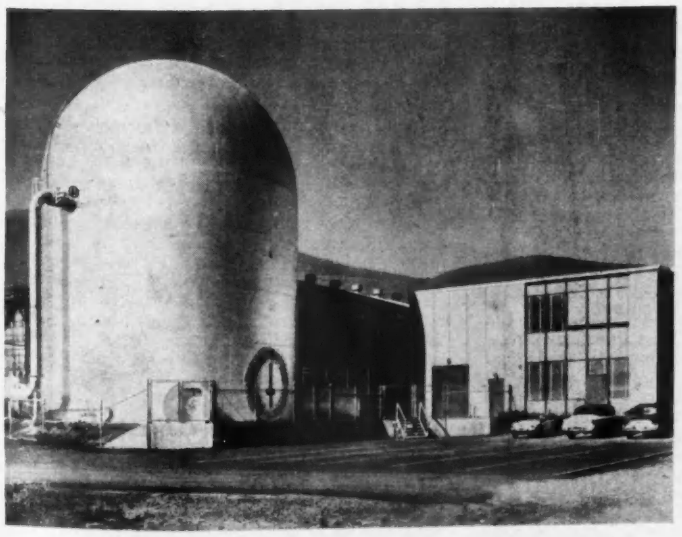


Fig. 7—Current construction progress at the Dresden atomic power station of the Commonwealth Edison Company near Chicago

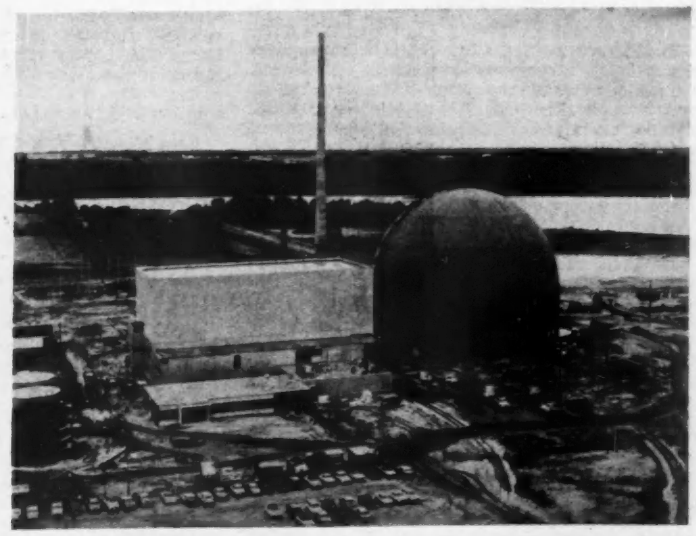


Fig. 8—15tMW Organic Moderated Reactor Experiment of Atomics International at the National Reactor Testing Station in Idaho

Personal and Business

Appointments

FOLLAND AIRCRAFT, Ltd., has announced that Air Marshal Sir Richard Atcherley has joined the board of the company as sales director.

MR. LESLIE OLORENSHAW, a member of the executive board of the Taylor Woodrow Group, has been appointed a member of the parent board of Taylor Woodrow, Ltd.

SQUARE D, Ltd., has announced the appointment of Mr. C. R. Robinson as branch manager of its newly-opened field office at 91, Pilgrim Street, Newcastle upon Tyne (telephone Newcastle 25810).

MR. R. GAVIN ORR has been appointed managing director of T. C. Jones and Co., Ltd., in succession to Mr. I. Levin, M.I.C.E., M.I.Mech.E., who is approaching retiring age. Mr. Levin remains a director of the company.

MR. MAURICE KEITH WING of C.A.V., Ltd., has taken up an appointment as project engineer for the company in Canada. He will operate from the parent company's office, Joseph Lucas (Canada), Ltd., 11, Davies Avenue, Toronto, 8.

SHARPLES CENTRIFUGES, Ltd., has announced the appointment of Mr. Robert D. Fisher as manager of the newly-formed oil projects division. Mr. Edward C. C. Harvey has been appointed senior project engineer responsible for the company's activities in south-east England.

BRUCE PEEBLES AND CO., Ltd., announces that Mr. W. M. Clark has been appointed manager, Glasgow office, in succession to Mr. J. H. P. de Villiers, and Mr. L. B. Torond has been appointed manager, London office, in succession to Mr. N. L. Jones. Mr. de Villiers and Mr. Jones have been appointed divisional directors of the company.

MR. C. T. M. BAGNALL, publicity manager of the English Electric Company, Ltd., has been elected chairman of the publicity and exhibitions committee of the British Electrical and Allied Manufacturers' Association (Incorporated) for the 1959–60 session. Mr. G. M. C. Peacock, manager of the publicity department of Babcock and Wilcox, Ltd., has been elected vice-chairman.

THE BRITISH CHEMICAL PLANT MANUFACTURERS ASSOCIATION states that the retiring chairman, Mr. H. W. Fender, the vice-chairman and managing director of Prodorite, Ltd., was elected for a further year and that the following were elected to the Council: Messrs. P. D. Doulton, E. S. Franklin, N. C. Fraser, Dr. R. Lessing, Messrs. R. C. Odams, B. N. Reavell, R. W. Rutherford, P. W. Seligman and R. F. Stewart.

ASQUITH MACHINE TOOL CORPORATION, Ltd., has announced appointments to the boards of Kitchen and Wade, Ltd., and Ormerod Shapers, Ltd. The board of Kitchen and Wade, Ltd., now consists of Mr. Robert W. Asquith, chairman; Mr. W. A. Hannaby, managing director; Mr. G. W. Wright, Mr. J. Blakiston, Mr. J. D. H. Horobin, Mr. F. Spenser and Mr. M. E. Wood. Ormerod Shapers, Ltd., now becomes a direct subsidiary of Asquith Machine Tool Corporation, Ltd., and its directorate consists of Mr. Robert W. Asquith, chairman, Mr. E. Stott, managing director, Mr. J. D. H. Horobin, Mr. W. A. Hannaby, and Mr. F. Spenser.

THE MOND NICKEL COMPANY, Ltd., announces that with effect from June 1, Dr. G. L. J. Bailey has been appointed superintendent of the development and research department laboratory, Birmingham. Dr. W. Betteridge has been appointed superintendent of the platinum metals research laboratory of the development and research department, and Dr. W. Steven, superintendent of the development and research department laboratory, Birmingham, is being transferred to the development and research division of the International Nickel Company Inc., New York, as director of research. He has also been elected as assistant vice-president of that company.

Business Announcements

UDDEHOLM, Ltd., states that the address of its head office is now Crown Works, Northwood Street, Birmingham, 3 (telephone Central 8971).

MECHANICAL ENGINEERING RESEARCH LABORATORY, East Kilbride, Glasgow, states that its name has been changed to National Engineering Laboratory.

G. MAUNSELL AND PARTNERS states that their address is now Greener House, 66, Haymarket, Westminster, London, S.W.1. (telephone Whitehall 4025).

MR. H. D. CROFTS, chief designer, has retired from the Willesden works of the Lancashire Dynamo and Crypto, Ltd., after completing forty-nine years' service with the company.

TECHNOGRAPH PRINTED CIRCUITS, Ltd., and TECHNOGRAPH ELECTRONIC PRODUCTS, Ltd., are occupying new office accommodation at Eros House, 29-31, Regent Street, London, S.W.1 (telephone Regent 5273/5).

RANSOME AND MARLES BEARING COMPANY, Ltd., Newark-on-Trent, has opened a new branch office at 42, London Road, Southampton (telephone Southampton 28871). Mr. G. D. Ball has been appointed manager of this new branch.

THE REED PAPER GROUP OF COMPANIES, Aylesford site, near Maidstone, Kent, states that from June 9, its telephone number will be Maidstone 7-7777. This will replace the following numbers: Maidstone 7157, 7233, 7242, 7273, 7281, 7361, 7383, 7417, 7424, 7461 and 7481.

COMMERCIAL ROAD VEHICLES, Ltd., Ardee Road, Dundalk, Co. Lough, one of the I.E.C. Group of Companies, is now manufacturing A.E.C. passenger and goods vehicle chassis. The company has also taken over the sales and service of all A.E.C. vehicles formerly undertaken by A.C.V. Sales, Ltd.

H. W. KEARNS AND CO., Ltd., is now represented in Canada by B.S.A. Tools, Ltd., 228, Norseman Street, Toronto, 18, Ontario (telephone Belmont 3-1209). The company's representative for the provinces of British Columbia and the Yukon remains, B.C. Equipment Company, Ltd., B.C. Equipment Building, 551, Howe Street, Vancouver, 1.

G.W.B. FURNACES, Ltd., P.O. Box No. 4, Dibdale Works, Dudley, Worcs., states that agreements have now been concluded for co-operative manufacture and sale, in Great Britain and most of the Commonwealth countries, of the whole range of melting plant designed by Demag-Elektrometallurgie, G.m.b.H., Duisberg, Germany, and by the Lectromelt Furnace Division, McGraw-Edison Company, Pittsburgh, U.S.A.

THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS announces that the Directors of the Austrian, Belgian, British, Dutch, French, German, Italian, Swedish and Swiss Chemical Manufacturers Associations have decided, that in view of the problems facing the chemical industries in their respective countries, to set up a Centre Europeen des Federations de l'Industrie Chemique. The secretarial services have been entrusted to the Swiss Association in Zurich.

Contracts

RUSTON AND HORNSBY, Ltd., has received a contract worth approximately £300,000 from the Air Ministry for the supply of Paxman Mark 12YHX 410kW diesel generating sets. The electrical generators of these sets are driven by vee-form 580 b.h.p. diesels built by Rustons' associate company, Davey, Paxman and Co., Ltd.

BIRWELCO, Ltd., and its subsidiary, Brown Fintube (Great Britain), Ltd., have received an order valued at £300,000 for the supply of six Petro-Chem Iso-Flow furnaces and tank heaters at the Rio Duque de Caxias refinery, Brazil, for Petroleo Brasileiro, S.A. The main contractor for the refinery is the Foster-Wheeler Corporation, in conjunction with Foster-Wheeler, Ltd., London.

JOHN HOWARD AND CO., Ltd., has been awarded by the Staffordshire Potteries Water Board the contract for heightening the embankment of Tittesworth reservoir. The work involves heightening the existing dam from 50ft to 100ft, and the construction of outlet works and two road diversions. The contract is due to be completed by April, 1962, and its value is in the region of £750,000. The consulting engineers are Messrs. Binnie, Deacon and Gourley.

DAVY AND UNITED ENGINEERING COMPANY, Ltd., has received an order from Steel, Peech and Tozer, branch of the United Steel Companies, Ltd., for a new cold strip mill for the Brinsworth plant. Fed by the Brinsworth hot strip mill (THE ENGINEER, December 19, 1958), the new cold reduction mill, a 104in and 26in by 22in four-stand tandem, will be capable of rolling mild steel and high carbon strip from 4in to 18in wide at speeds up to 2100ft per minute. It will be supplied complete with a full range of auxiliary equipment capable of the mechanical handling of coils of strip eventually weighing over 5 tons each. The mill will be equipped with automatic gauge control.

Miscellanea

CENTRES ON INJECTION MOULDING MACHINES.—To ensure interchangeability of moulds between injection moulding machines made by different manufacturers, without hindering design development or individual needs, a specification has been drawn up by the British Plastics Federation for mould fixing centres on injection moulding machines. This specification is published by the British Plastics Federation and obtainable from its offices, 47–48, Piccadilly, London, W.1, price 3s., post free.

METAL CONDITIONER FOR PAINT.—A new "Pitan" metal conditioner which is suitable for use on non-ferrous and ferrous metals has been introduced by Allweather Paints, Ltd., 36, Great Queen Street, London, W.C.2. It is stated to be so formulated that it bonds into and becomes an integral part of the metal and forms an adhesive film and not a cohesive film like paint. The conditioner has a high solvent resistance and is suitable as a primer for most types of paint, synthetic finishes, stove enamels, &c. It is supplied as a single solution and can be safely left in open pots for a reasonable time without solidifying or even "skinning."

INERT GAS GENERATOR.—A new design of inert gas generator which is being developed by the dryer and gas plant division of Birlec, Ltd., Erdington, Birmingham, is designed to supply the large volume of inert gas, which is often required to purge fuel tanks, gas holders, and pipe systems before they are opened to the atmosphere for cleaning and maintenance work. This inert gas generator will have a capacity of 200,000 cubic feet per hour. In it air mixed with propane is ignited within a sealed cylinder and the inert gases generated by the combustion are collected and employed for purging. Development work is at present being directed to the introduction of optimum burner sizes for use in a range of generators.

PHOTOMULTIPLIER TUBES.—Eight new photomultiplier tubes for scintillation counting and industrial applications are being introduced by Mullard, Ltd., Mullard House, Torrington Place, London, W.C.1. They comprise one 15-stage, five 11-stage and two 10-stage tubes. All have maximum spectral response in the blue/violet region (4000Å to 4200Å), and two are fitted with quartz windows to allow adequate response to ultra-violet radiation. The tubes are designed for end-on viewing and have caesium-antimony photocathodes of from 20mm to 111mm in useful diameter, with optically flat and parallel surfaces. Besides their uses in scintillation counting, the tubes have applications in photometry, pyrometry, and many kinds of industrial counting, control and measurement processes.

CHEAPER RADIOTELEPHONE CALLS TO SHIPS.—From May 1 the charge for a direct telephone call in the long-range radiotelephone service between the United Kingdom and ships at sea, over about 1000 miles from Britain, has been reduced from £3 12s. 0d. to £3 0s. 0d. This has put long-distance ship-to-shore telephone call charging on a similar basis to that for most countries outside Europe. The G.P.O. operates its long-distance ship-shore radiotelephony service through stations at Rugby and Criggion. Charges for telephoning ships participating in the service vary according to which of two zones the ship is in when the call is made. The first zone reaches out to mid-Atlantic and also includes the Mediterranean; the second covers the remaining seas of the world. It is to cheapen calls to this latter zone that the reduction has been made.

ALUMINIUM AND METHANE.—The film "Aluminium for Sub-Zero Methane" which has been produced for the Aluminium Development Association, recalls the arrival of the first cargo of liquid methane in this country and the essential part played by aluminium in the success of the experiment. Research carried out by member companies of the association and by Lloyd's Register of Shipping indicated the suitability of certain alloys for operation at the low temperature associated with liquid methane. These researches resulted in the fitting of five 400-ton capacity aluminium alloy tanks in the "Methane Pioneer," which the film shows arriving off Canvey Island. The main part of the film is concerned with the construction of two 1000-ton capacity aluminium storage tanks, one built by the A.P.V. Company, Ltd., and the other by Whessoe, Ltd., and the two 2000ft aluminium alloy pipelines running from the jetty to the tanks. Stages in the construction are shown in the film which illustrates the site welding operations using the inert gas metal arc system and the 100 per cent inspection of all joints. The 16mm colour film has a running time of seventeen-and-a-half minutes and is available on loan from the Aluminium Development Association, 33, Grosvenor Street, London, W.1.

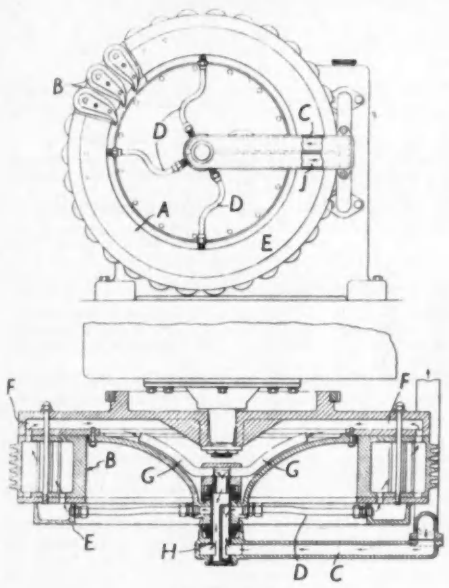
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings, unless otherwise stated. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

INTERNAL COMBUSTION ENGINES

811,454. February 7, 1956.—Liquid-Cooled Internal Combustion Engines, Minneapolis-Moline Company, 130, Ninth Avenue South, Hopkins, State of Minnesota, United States of America. (*Inventor: William Eugene Swenson.*)

This invention concerns an engine cooling system in which there are combined the actions of the radiator, pump and fan in a single rotary element, which so circulates the coolant that its weight may be utilised for a flywheel effect. Referring to the drawing, the cooling and flywheel mechanism is driven by the shaft from the engine. It consists of a rotating element including a rotor *A* which carries a series of hollow fan blades *B* around its outer periphery. The back plate of the rotor has a hub by which it is secured to the shaft. The blades are curved inwards



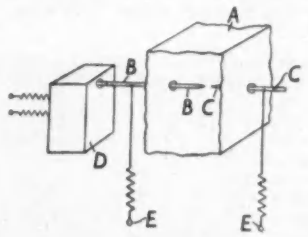
No. 811,454

and forwards so that they will scoop air from the centre of the rotor and expel it outwards as the fan rotates. Coolant from the engine is taken in through the bore *C* and centrifugally pumped outward through the tubes *D* into the manifold *E* from which coolant enters the chambers in the fan blades. The coolant flows through the chambers to the outlet openings near the periphery and into the chamber *F*. As the body of coolant spins with the fan, stationary tubes *G* scoop up liquid and return it through the sleeve *H* and bore *J* to the engine, setting up a continuous circulation through the entire system. No separate pump is required for circulation, the centrifugal effect being more than sufficient for the purpose. As the liquid is driven through the fan blades it passes over and around the baffles which ensure efficient heat exchanging relation with the air being blown past the outside; thus the blades serve the dual functions of a fan and radiator. Since the blade chambers are constantly filled with coolant as it circulates through the system the weight of this liquid adds a flywheel effect and the combination fan and radiator thus serves the third function of a flywheel for the engine. The invention also embraces a new method of engine cooling, including the centrifugal pumping of the liquid coolant through the chambered fan blades, by bringing the coolant from the engine to the axis of rotation so that it may be driven centrifugally outwards through the fan blades. The cooled liquid is in this case collected by stationary scoops for return to the engine.—*April* 8, 1959.

TELECOMMUNICATIONS

811,040. June 3, 1957.—Spark Gap Microwave Generators, Marconi's Wireless Telegraph Company, Ltd., Marconi House, Strand, London, W.C.2. (*Inventors: Jean Sumpton and Stanley Charles Snook.*)

This invention has for its object to provide simple and economical generators whereby microwaves of the order of a few millimetres in wavelength can be generated by means of a spark gap. In the simplest way of carrying out the invention one of the electrodes is fixed and the other is vibratorily reciprocated by means such as a loudspeaker movement or buzzer movement. Neither the frequency nor the amplitude of variation of the spark gap length is critical. The invention is illustrated in the drawing where *A* is a

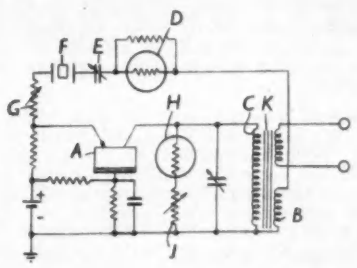


No. 811,040

waveguide of rectangular form having small holes in its opposite broad faces. Two tungsten electrodes *B* and *C*, of which the electrode *C* is fixed, project through these holes into the guide. Electrode *B* is vibrated in the direction of its length by a vibratory motor represented by the block *D*. The motor may take any of a variety of forms depending upon the frequency of vibration. For example, if the frequency of vibration is 50 c/s the motor may be a simple buzzer movement. If a higher frequency of vibration is required, for example, 500 c/s, the motor may be a loudspeaker movement having a vibratory diaphragm to which the electrode *B* is attached. A high voltage, for example, 5kV, is applied at terminals *E* across the spark gap between the two electrodes. The amplitude of vibration is chosen at a value such that twice per cycle of vibration the length of the spark gap is of the fairly critical value (having regard to the high voltage applied) required to produce microwaves of the frequency required. The microwave frequency produced by a spark gap, is, of course, a function of its length and of the voltage across it. Because the length of the spark gap is varied in oscillatory fashion, corrosion and wear of the electrodes are not of major adverse effect and the main defect of known spark gap microwave sources, namely that they require extremely critical adjustment, is avoided.—*March* 25, 1959.

811,095. October 18, 1957.—Stabilised Transistor Oscillators, Standard Telephones and Cables, Ltd., Connaught House, 63, Aldwych, London, W.C.2. (*Inventor: Ian Barry Vaughan Frost.*)

In some carrier current communication systems transistors are tending to replace valves chiefly because the power consumption is so much less. The characteristics of transistors are liable to vary rather widely with changes in the supply voltage and temperature and the object of the invention, therefore, is to provide a transistor oscillator circuit with improved stabilising means. Referring to the drawing, a feedback path between the collector circuit and the emitter circuit of the transistor *A* is formed by an additional secondary winding *B* of the transformer *C* having one terminal connected to ground and the other to the emitter electrode through a block thermistor *D*, an adjustable capacitor *E*, a piezoelectric crystal *F* and an adjustable resistor *G*. The



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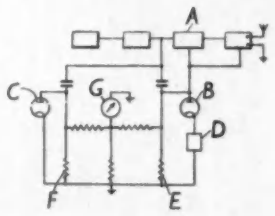
frequency of oscillation is determined by the piezoelectric crystal *F* which acts as a series-resonant device effectively connecting the collector and emitter electrodes of the transistor. Thermistor *H* and resistor *J* form a combination which can be made to maintain the voltage across the transformer *K* substantially constant, assuming that the mean temperature of the thermistor remains constant. If, however, the mean temperature of the thermistor changes due, for example, to a change in the room temperature, the voltage across transformer *K* will be stabilised at a different value. To overcome this, the block thermistor *D* is provided and should be mounted close to thermistor *H* so that both are subjected to the same external temperature. The block thermistor consists of a relatively large body of thermistor material whose temperature is determined by the temperature of the space in which it is enclosed, and is not affected appreciably by the currents which pass through it. Then if, for example, the external temperature rises, thermistor *H* will tend to stabilise the output voltage at a lower value. However, the resistance of the block thermistor *D* will fall, and this will increase the feedback, which tends to raise the output voltage, so compensating for the tendency for the thermistor *H* to stabilise the output voltage at a lower value.—*April* 2, 1959.

811,179. March 22, 1957.—Tuning Indicator Circuit, Marconi's Wireless Telegraph Company, Ltd., Marconi House, Strand, London, W.C.2. (*Inventor: William Townsend Eastwood.*)

This invention relates to tuning indicator circuit arrangements suitable for use in radio receivers and other tunable high frequency equipment, and is intended to avoid the drawback of existing circuits in which either the discrimination is poor above a certain signal strength, or no indication is given below a certain threshold. The diagram shows the invention applied to a radio receiver of the heterodyne type. Output from the intermediate frequency portion *A* of the equipment is fed in parallel through condensers to two rectifiers shown as constituted by diodes *B* and *C*, one of which—the diode *B*—is a so-called "delayed" rectifier delayed by a pre-



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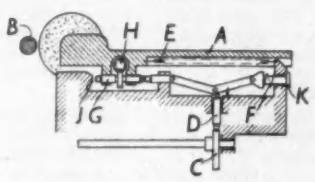
determined and, if desired, variable bias applied by a bias source *D*. Resistances *E* and *F* constitute the load resistances of the two diodes. The anode of the diode *B* provides automatic gain control bias in the receiver in the usual way. The arrangement shown provides a means responsive to signal strength level for producing a first control signal, and means responsive to signal strength level exceeding a predetermined level for producing a second control signal. It will be seen that the resistive network fed from the anodes of the diodes constitutes a simple resistive summation network combining the control signals to produce a resultant which operates the indicator *G* which is shown, for simplicity, as a meter but would, of course, be a valve voltmeter circuit arrangement.—*April* 2, 1959.

MACHINE TOOLS

810,997. May 29, 1957.—In-Feed of Machine Tool Carriages, Aktiengesellschaft Fritz Studer, Maschinenfabrik, Glockenthal-Thun, Switzerland.

This invention relates to mechanism for providing an in-feed movement without backlash of a machine tool carriage and for obtaining accurate in-feed end positions of the carriage without backlash and at constant pressures. One form of the invention, applied to a precision grinder, is shown, by way of example, in the accompanying drawing. The in-feed of the carriage *A* towards the workpiece *B* is produced by a cam *C* on a drive shaft mounted in the bed. It will readily be apparent that, when the cam is rotated the push rod *D* gradually extends a toggle lever, the carriage being fed in to the left against the action of the spring *E*. The force of the spring *E*, which is less than that of the spring *F* at one end of the toggle linkage, precludes any play in the links or in the thread of the stroke setting pin *G*, which is adjusted by a worm *H*. In the preset in-feed end position the pin *G* bears against the abutment *J*, and any further movement of the push rod so actuates the lever mechanism that the pin *K* is urged back against the load of the spring *F*. The maximum thrust applied by the pin *G* to the abutment *J* at the end of each



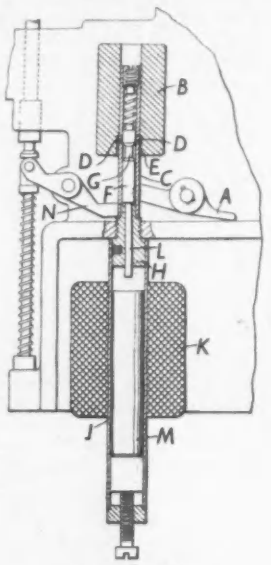
No. 810,997

in-feed is a constant determined by the pressure of the spring *F*, and since the spring *E* is not relieved of load this end position is free from backlash.—*March* 25, 1959.

ELECTRICAL ENGINEERING

811,142. July 22, 1955.—ELECTRIC SWITCHGEAR WITH TRIPPING MEANS, The English Electric Company, Ltd., Queens House, 28, Kingsway, London, W.C.2. (*Inventor : John Molyneux.*)

On certain classes of electric switchgear such as switchgear for mining applications, it is necessary to provide sensitive earth leakage protection capable of tripping the circuit breaker when as little as 5 per cent of normal line current passes to earth. According to the invention, an earth leakage trip device for an electric circuit breaker comprises an earth leakage sensing coil, a magnetic member responsive to current in said coil, and a weight arranged to fall from a raised position on to a mechanical tripping element of said circuit breaker, this weight being normally held in its raised position by a " ball latch " arranged within the weight and operable by an upward movement of the magnetic member. In the drawing, a circuit breaker trip bar (not shown) is operable for tripping the circuit breaker by the right-hand end of a transfer lever *A* being moved upwards. The left-hand end of the lever is operable by a weight *B*



No. 811,142

which is arranged so as to be capable of falling upon it. The weight is arranged to slide on a vertical tube *C* and is retained in the elevated position shown in the drawing by a pair of steel balls *D*, located in radial holes in the wall of the tube *C*, which project to a small extent beyond the outer surface of the tube into a chamber *E* in the lower end of the weight *B*. Arranged within the tube *C* is a plunger *F* having a reduced central portion *G* connected to an upper end portion by a chamfer. When the end portion is adjacent the radial bores in the tube wall, the balls *D* are maintained projecting slightly from the outer face of the tube *C*. The tube is an extension of the pole piece *H* of a tripping solenoid *J* which has an operating coil *K* supplied with energy by earth leakage sensing means. The plunger *F* has an extension *L* which projects through the pole piece and is engaged, when the coil *K* is energised, by a solenoid plunger *M*. After the weight *B* has fallen, it is reset by movement of a resetting lever *N* which bears against the lower end of the weight and raises it a little beyond the position shown in the drawing. The plunger *F* is then able to fall, pushing the balls *D* out into the chamber *E* so that the weight is held in its uppermost position.—*April* 2, 1959.

Launches and Trial Trips

QUEDA, oil tanker ; built by Scotts Shipbuilding and Engineering Company, Ltd., for the British India Steam Navigation Company, Ltd. ; length between perpendiculars 534ft, breadth moulded 71ft 8in, depth moulded 39ft 6in, deadweight 19,045 tons, draught 30ft 2in ; twenty-seven cargo oil tanks, two cargo pump rooms ; two 550kW turbine-driven alternators, one 200kW diesel-driven emergency alternator ; one set of double reduction geared turbines, 8000 s.h.p. Trial, March.

POOLTA, cargo ship ; built by Henry Robb, Ltd. for the Union Steam Ship Company of New Zealand, Ltd. ; length between perpendiculars 250ft, breadth moulded 43ft, depth moulded to upper deck 17ft 6in, deadweight 2180 tons on 16ft 1¾in mean draught, trial speed 11 knots ; three holds, bale capacity 109,000 cubic feet ; ten 5-ton derricks, electric deck machinery ; three 135kW diesel-driven generators ; Clark-Sulzer, Mark TD48, five-cylinder, two-stroke diesel engine, 1500 b.h.p. at 225 r.p.m. Launch, March 10.

PRESTO, oil tanker ; built by Verolme Shipyard Heusden N.V. for A/B Turret O/Y, Finland ; length between perpendiculars 538ft, breadth 71ft 10in, depth 39ft 4¼in, deadweight 19,900 tons ; twenty-seven oil cargo tanks ; trial speed 15·2 knots ; Verolme-M.A.N. diesel engine, 7500 b.h.p. Trial, March 5.

SAN GASPAR, oil tanker ; built by Cammell Laird and Co. (Shipbuilders and Engineers), Ltd., for the Eagle Tanker Company, Ltd. ; length between perpendiculars 635ft, breadth moulded 84ft 3in, depth moulded 46ft 3in, summer draught 34ft 4in, deadweight 32,000 tons ; thirty cargo oil tanks, one main pump room ; two 550kW, 450V, 60 c/s turbo-alternators, one 200kW diesel-driven alternator ; one set of double reduction geared turbines, 14,500 s.h.p. ; two Babcock and Wilcox boilers supply steam at 600 lb per square inch superheated to 850 deg. Fah. Launch, March 10.

MISS CHANDRIS, cargo liner ; built by William Doxford and Sons (Shipbuilders), Ltd., for Evmyrania Navegacion S.A. ; length between perpendiculars 470ft, breadth moulded 67ft, depth moulded to upper deck 40ft 8in, deadweight 14,550 tons, speed 15½ knots ; five holds and a deep tank, one 50-ton, six 10-ton and six 5-ton derricks, steam winches ; Doxford opposed piston oil engine, six cylinders, 700mm diameter by 2320mm combined stroke. Launch, March 11.

BRITISH DESTINY, oil tanker ; built at the Wallsend yard of Swan, Hunter and Wigham Richardson, Ltd., for B.P. Tanker Company, Ltd. ; length between perpendiculars 665ft, breadth moulded 95ft, depth moulded 51ft, deadweight 42,000 tons on 38ft 8in draught, service speed 16 knots ; eleven centre tanks port and starboard and eleven wing tanks port and starboard, one main cargo pump room, three 1000 tons per hour turbo-driven centrifugal two-stage pumps and three vertical stripping pumps ; two 750kW turbine-driven alternators and one 200kW diesel-driven alternator ; one set of double reduction geared turbines, 17,600 maximum shaft horsepower at 108 propeller revolutions per minute, take steam at 600 lb per square inch and 850 deg. Fah. from two Babcock and Wilcox " Selectable Superheat " boilers. Launch, March 11.

SWAN RIVER, cargo liner ; built by the Greenock Dockyard Company, Ltd., for the British Steam Navigation Company, Ltd. ; length between perpendiculars 456ft, breadth moulded 63ft 6in, depth moulded 39ft 4¼in, deadweight 12,900 tons on 29ft 5in mean draught, speed 13½ knots ; bale capacity 630,000 cubic feet ; five cargo holds, two complete decks, six 12½-ton, eight 5-ton and two 2-ton derricks, electric winches ; three 180kW diesel-driven generators ; Hawthorn-Doxford opposed piston oil engine, five cylinders 670mm bore by 2320mm combined stroke, 5500 b.h.p. at 115 r.p.m. Trial, March 16-17.

MANCHESTER MILLER, cargo liner ; built at Belfast by Harland and Wolff, Ltd., for Manchester Liners, Ltd. ; length between perpendiculars 436ft, breadth moulded 62ft, depth moulded to upper deck 39ft 6in, gross tonnage 8600 ; twelve passengers ; two complete decks, five main holds, Macgregor steel hatch covers, eight 10-ton and eight 5-ton derricks, electric winches ; one 350kW turbo-generator, three 200kW diesel-driven generators, two Babcock and Wilcox boilers supply steam at 500 lb per square inch and 800 deg. Fah. to a set of double reduction geared turbines of 7000 s.h.p. Trial, March 19.

GLENISLA, trawler ; built by John Lewis and Sons, Ltd., for Messrs. Wood and Bruce ; length overall 133ft, breadth 25ft 6in, depth moulded 12ft 9in, fish room 6500 cubic feet ; electric trawl, 150 b.h.p., barrel capacity 800 fathoms of 2¾in warp, 125kW diesel-driven winch generator, two 20kW diesel-driven generators ; British Polar Mark M.44.M. diesel engine 640 b.h.p. at 250 r.p.m. Trial, March 24.

TEWKESBURY, cargo ship ; built by the Burntisland Shipbuilding Company, Ltd., for the Alexander Shipping Company, Ltd. ; length between perpendiculars 430ft, breadth moulded 61ft 9in, depth moulded 38ft 3in, deadweight 11,900 tons, load draught 28ft 10in ; five holds, one 50-ton, one 25-ton, six 12½-ton, eight 5-ton and two 2-ton derricks ; three 200kW diesel-driven generators ; Hawthorn-Doxford oil engine, 5500 b.h.p. at 115 r.p.m. Launch, March 25.

TATIANA, cargo ship ; built by the Chantiers Reunis Loire-Normandie for the Compagnie Maritime des Chargeurs Reunis ; length between perpendiculars 433ft 1in, breadth moulded 61ft, depth to shelter deck 35ft 9in, draught 24ft 1½in, deadweight 8000 tons ; five holds, capacity 452,000 cubic feet, one 50-ton, one 25-ton, sixteen 5-ton derricks ; load speed 16 knots ; l'Atlantique-Sulzer Mark 9 SD.72 diesel engine, 6300 h.p. at 125 r.p.m. Trial, March.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Tues., May 19.—EAST KENT BRANCH : Clarendon Hotel, Broadstairs, " Planned Maintenance," R. A. Rogers, 8 p.m. ★ TYNESIDE BRANCH : Crown Hotel, Newcastle, Branch Annual General Meeting, 7 p.m.

Wed., May 20.—LUTON BRANCH : Chamber of Commerce, George Street West, Luton, Branch Annual General Meeting and Lecturettes, 7.30 p.m.

Thurs., May 21.—ALDERSHOT AND DISTRICTS BRANCH : Red Cross Hall, High Street, Aldershot, Discussion on I.E.E. Regulations, 8.45 p.m.

BRITISH INSTITUTE OF MANAGEMENT

Tues., May 19.—PRODUCTION CONTROL STUDY GROUP : Management House, Fetter Lane, London, E.C.4, " Practical Case Study," R. H. Allen, 2.30 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Wed., May 27.—Grand Hotel, Charing Cross, Glasgow, C.3, " Economic Purchase of Coal for Small Plants," G. Armstrong, 10.30 a.m.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Thurs., May 21.—Room 127, City and Guilds College, Exhibition Road, London, S.W.7, " Uplift in Gravity Dams," Serge Leliavsky, 4 p.m.

INSTITUTE OF METALS

Thurs., May 28.—17, Belgrave Square, London, S.W.1, " The Atomic Mechanisms of Fracture," N. J. Petch, 6.30 p.m.

INSTITUTE OF NAVIGATION

To-day, May 15.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, " Electronic Surveys in the Caribbean," E. G. Irving, 5.15 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., May 26.—Great George Street, Westminster, London, S.W.1, " The Cape Town Wemmershoek Water Scheme," S. S. Morris, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Wed., May 20.—SUPPLY SECTION : Savoy Place, London, W.C.2, " The World Bank—What it is and What it Does," P. J. Squire, 5.30 p.m. ★ SHEFFIELD SUB-CENTRE : Grand Hotel, Sheffield, Annual General Meeting : " Earthing of Low and Medium-Voltage Distribution Systems and Equipment," F. Mather, 6.30 p.m.

Thurs., May 21, *to Wed., May* 27.—RADIO AND TELECOMMUNICATION SECTION : Earl's Court, London, S.W.5, International Convention on Transistors and Associated Semiconductor Devices.

INSTITUTION OF ENGINEERING DESIGNERS

Wed., May 20.—YORKSHIRE BRANCH : Midland Hotel, Bradford, Annual General Meeting, 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Thurs., May 21.—LONDON GRADUATES' SECTION : 1, Birdcage Walk, Westminster, London, S.W.1, Annual Meeting ; Discussion on " The Functions of the Institution and the Significance of Practical Training," 6.30 p.m.

INSTITUTION OF MINING AND METALLURGY

Thurs., May 21.—Geological Society, Burlington House, Piccadilly, London, W.1, Annual General Meeting ; Presidential Address, " Some Observations on Gold Refining and the Standard for Gold and Silver Coinage," J. H. Watson, 4 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, May 15.—S.W. COUNTIES BRANCH : Duke of Cornwall Hotel, Plymouth, Annual General Meeting, 6 p.m.

Thurs., May 28.—11, Upper Belgrave Street, London, S.W.1, Annual General Meeting, 6 p.m.

ROYAL STATISTICAL SOCIETY

Wed., May 20.—London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, Discussion on " Simulation Studies of Industrial Operations," opened by P. V. Youle, K. D. Tocher, W. N. Jessop and F. I. Musk, 5.15 p.m.

Tues., May 26.—MEDICAL SECTION : London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, Annual General Meeting ; " The Value of Periodic Health Examinations," J. C. McDonald, 5.30 p.m.

Wed., May 27.—London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, " Optimum Experimental Designs," J. Kiefer, 5 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Wed., May 20.—NEWCASTLE SECTION : King's College, Stephenson Buildings, Newcastle upon Tyne, Annual General Meeting, 7 p.m.

UNIVERSITY OF CAMBRIDGE

Mon., May 18, *to Fri., June* 19.—Engineering Laboratory, University of Cambridge, Trumpington Street, Cambridge, Exhibition to commemorate the Centenary of the death of Isambard Kingdom Brunel, 9 a.m. to 5 p.m. ; Sats., 9 a.m. to 12 noon.

WOMEN'S ENGINEERING SOCIETY

Thurs., May 21.—LONDON BRANCH : Hope House, 45, Great Peter Street, Westminster, S.W.1, " Aerial Survey Methods," 7 p.m.

Advanced Engineering Courses

Harwell Reactor School : Course for senior technical executives. REACTOR SCHOOL, ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, DIDCOT, BERKS. June 15 to 25. Fee, 50 guineas (exclusive of accommodation).

Control and instrumentation of Reactors. REACTOR SCHOOL, ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, DIDCOT, BERKS. The course is primarily intended for those who have a direct interest in the control and instrumentation of nuclear reactors, and it will be assumed that participants have some knowledge of the basic principles of these subjects. The course runs from July 7 to 17 inclusive. Fee, 50 guineas (exclusive of accommodation).

Post-graduate Course in Nuclear Power, 1959–60. IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON, S.W.7. The course is intended for students holding a good honours degree in mechanical, civil, electrical or chemical engineering. It will also be open to applied scientists who have graduated in physics or metallurgy. The course is full-time and of one year's duration. Fee for the full course, £124. Applications should be made before July 1.

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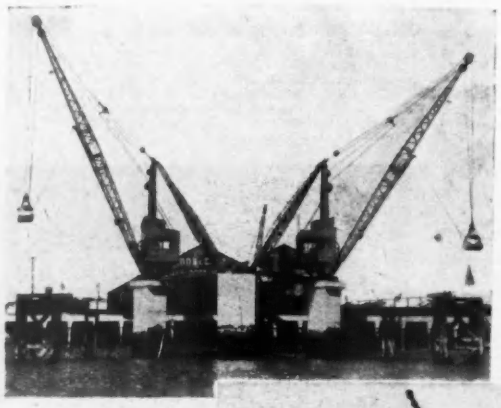

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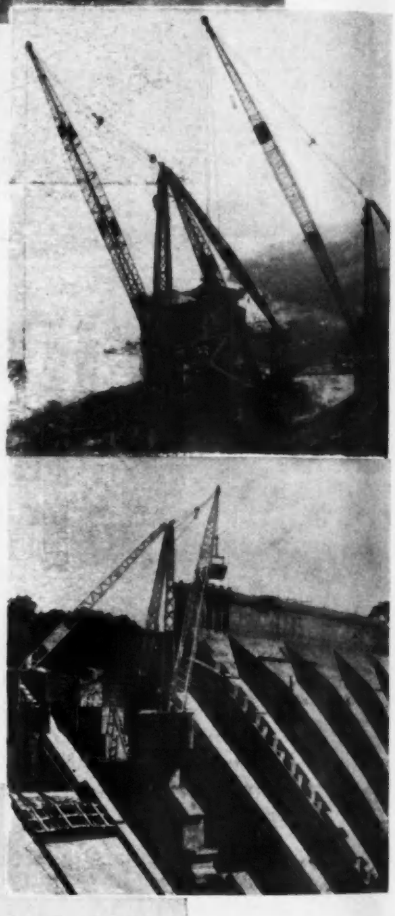

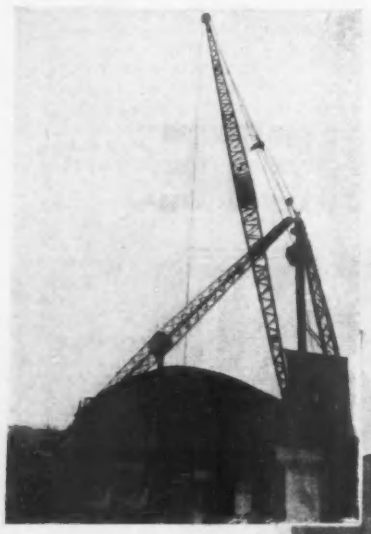

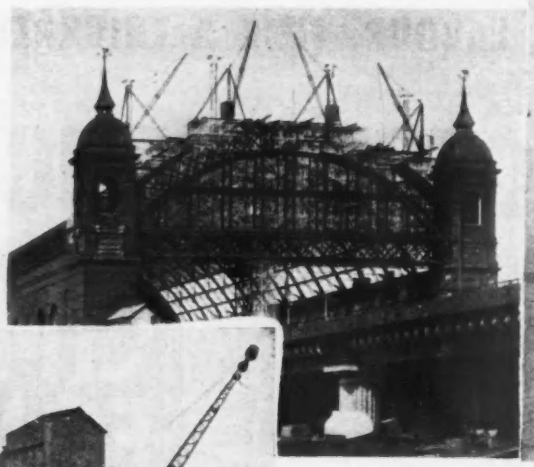

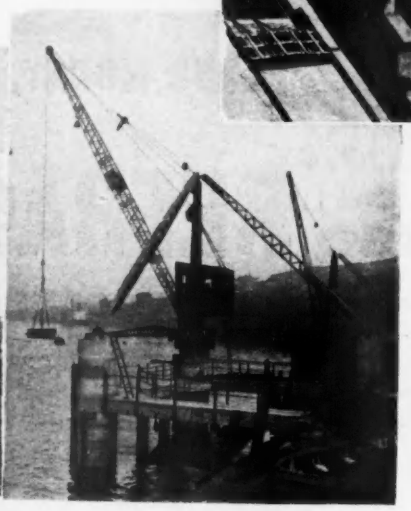

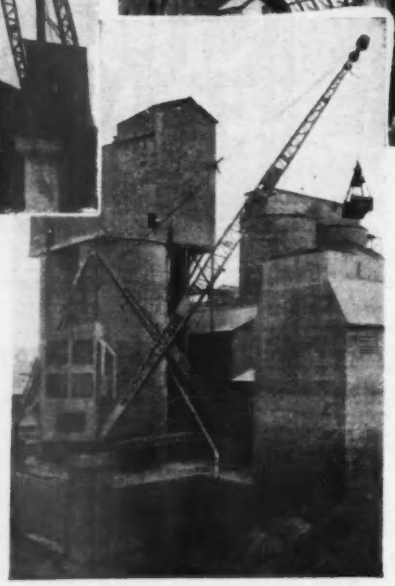

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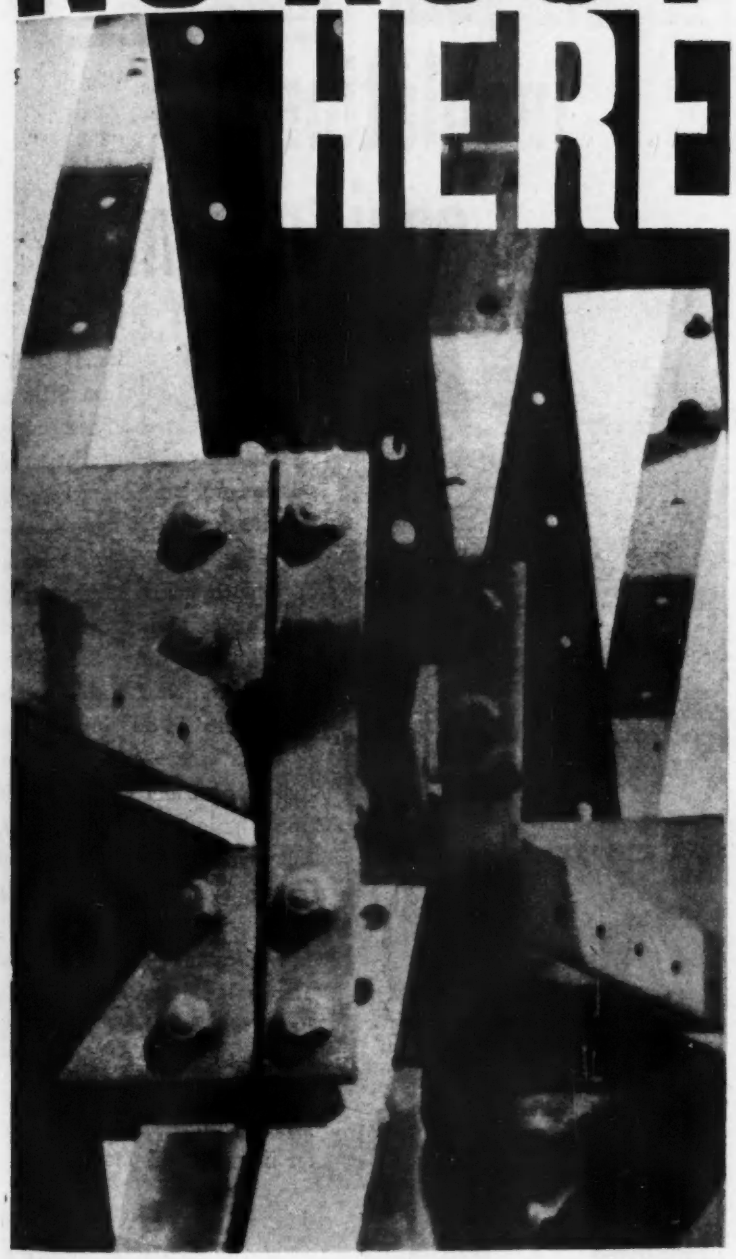

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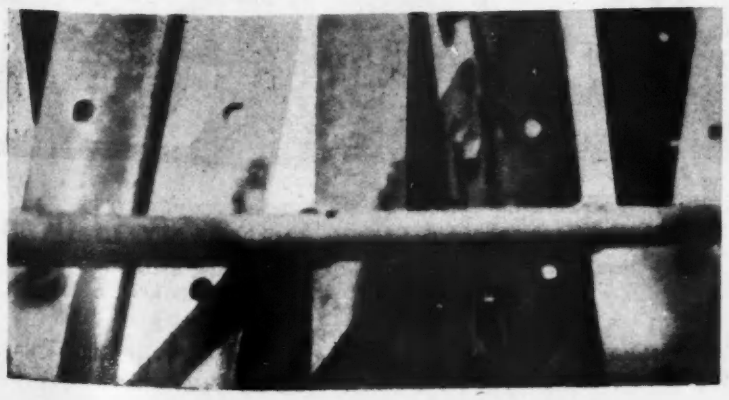

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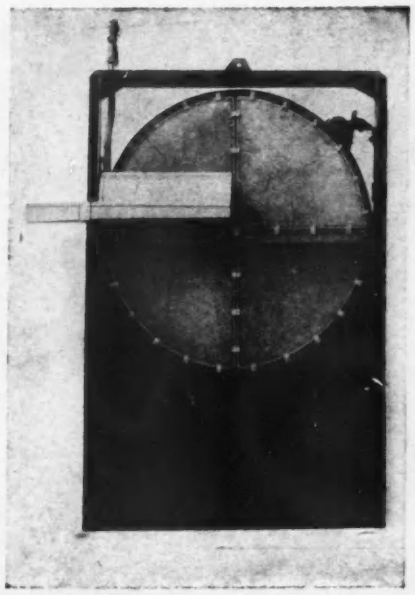

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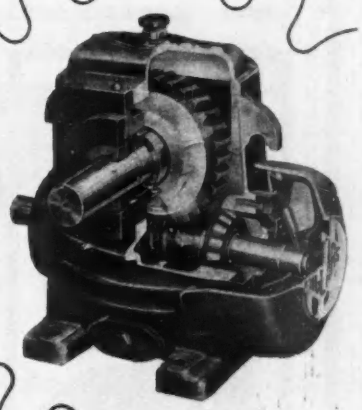

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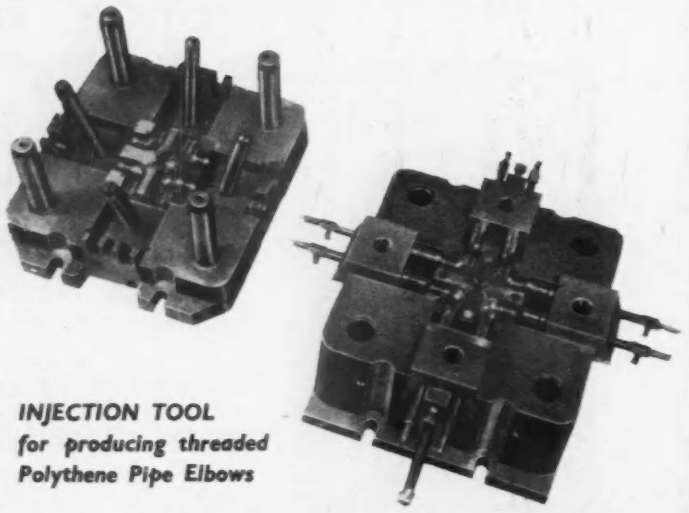

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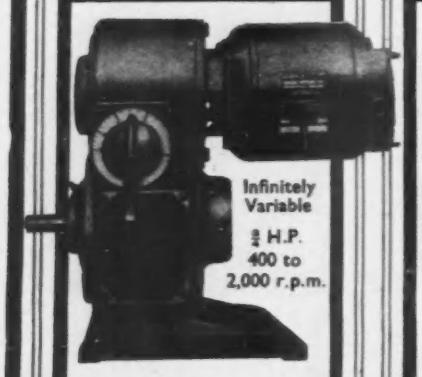

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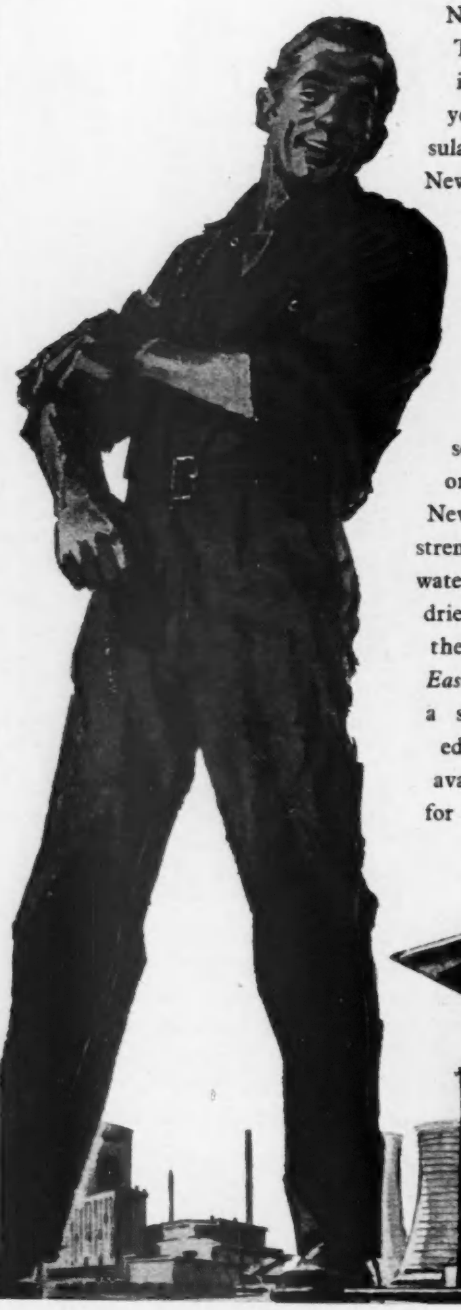

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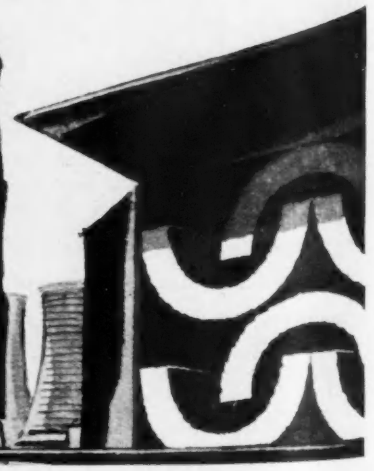

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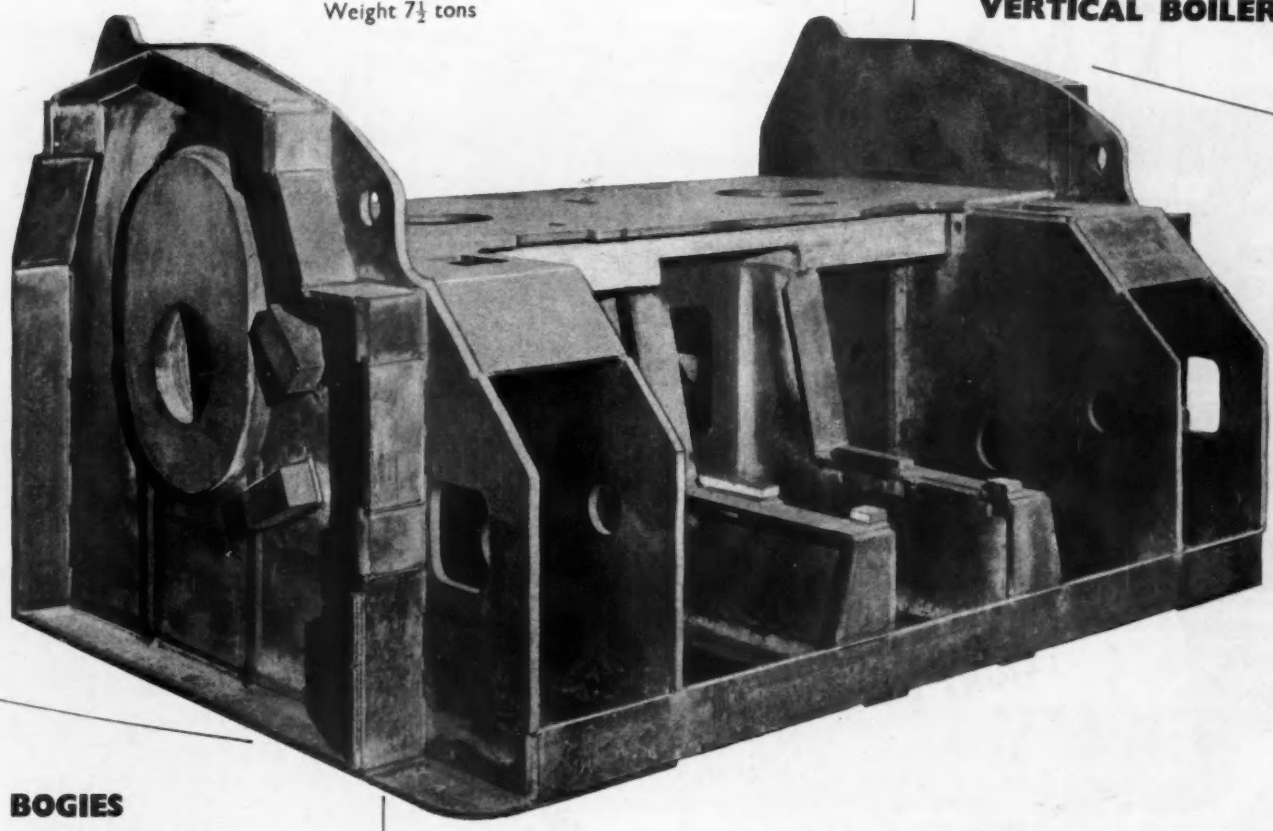

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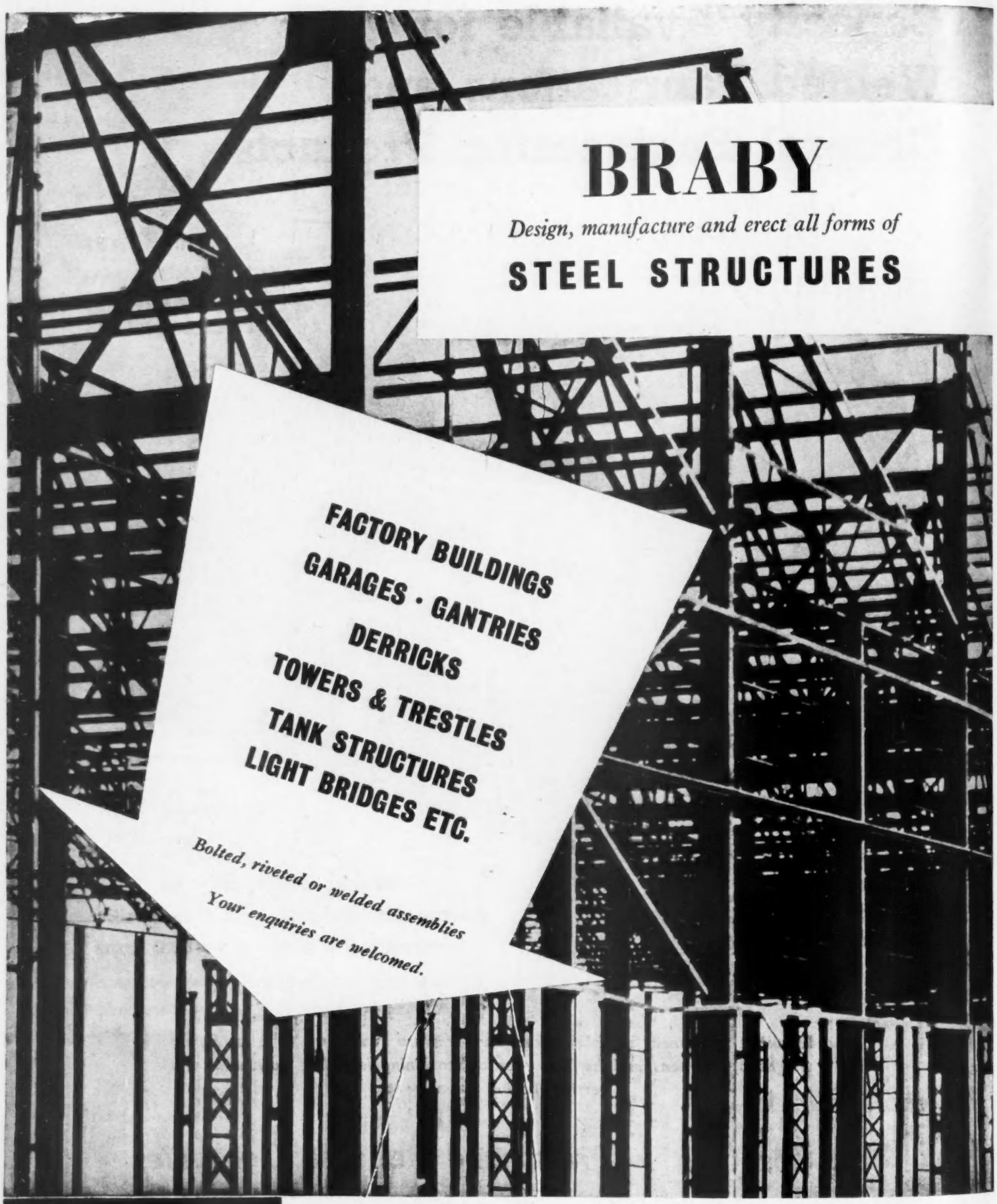

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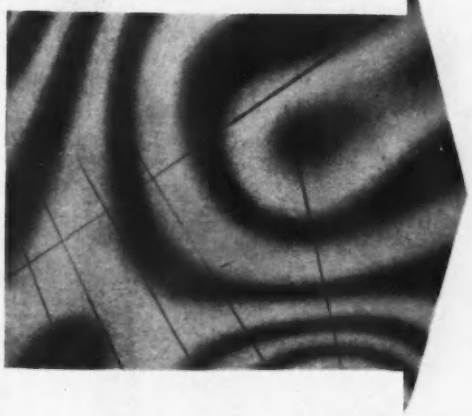

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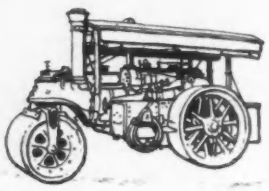

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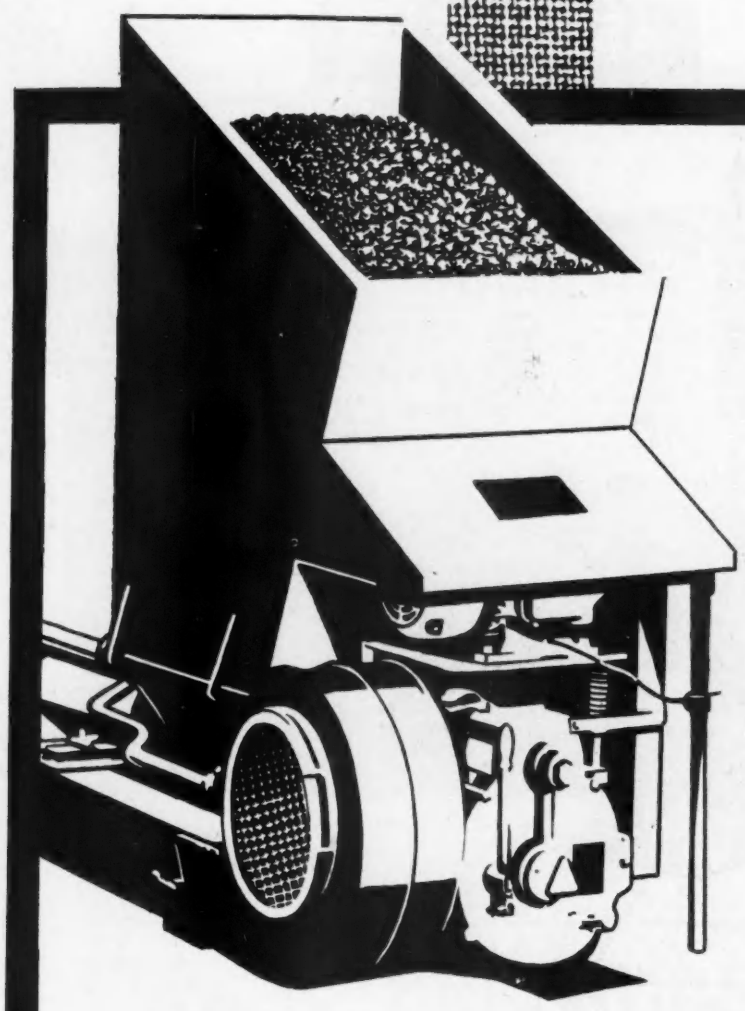

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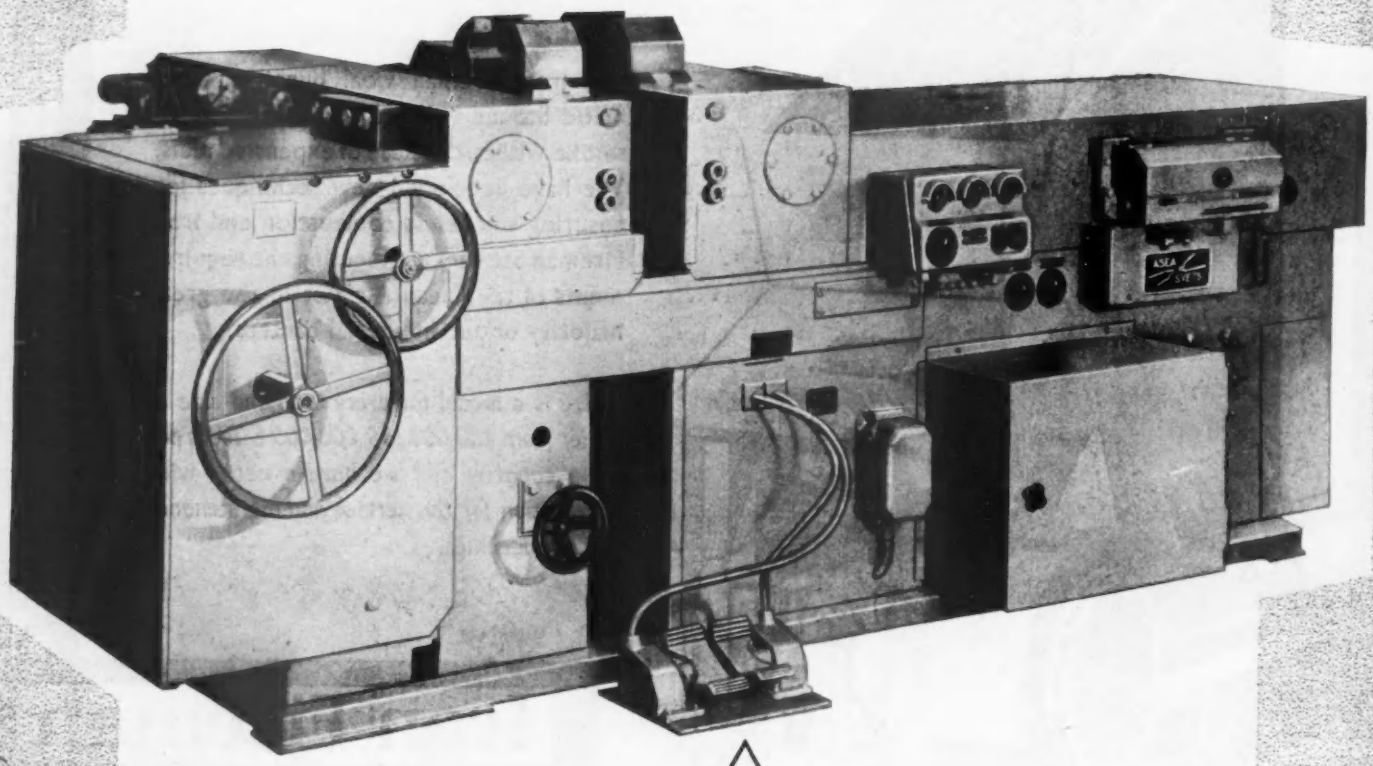

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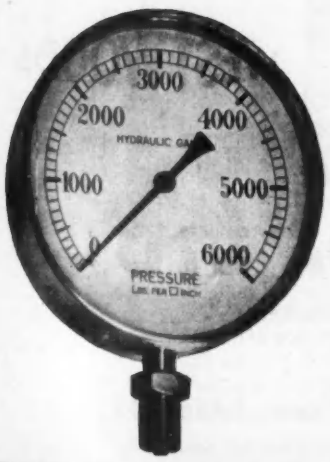

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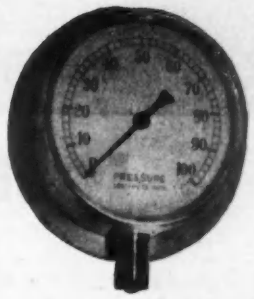

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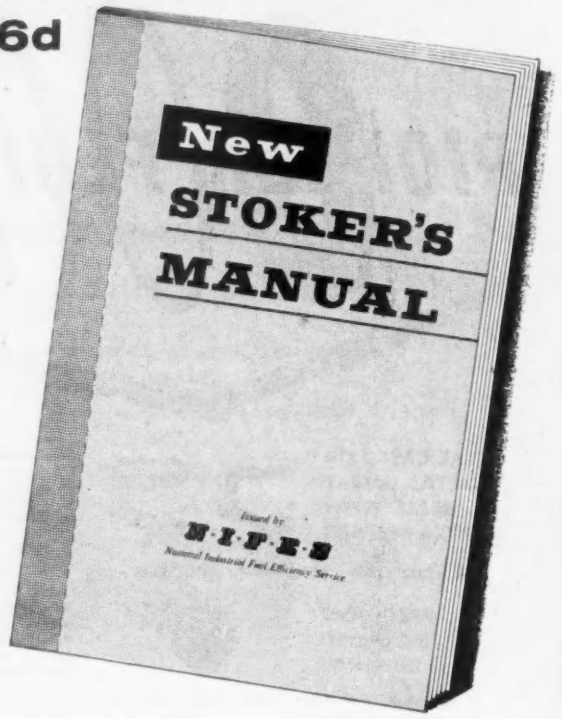

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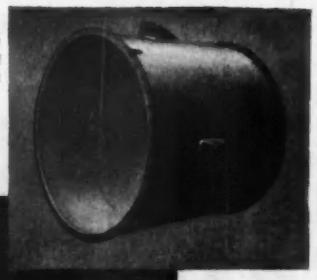

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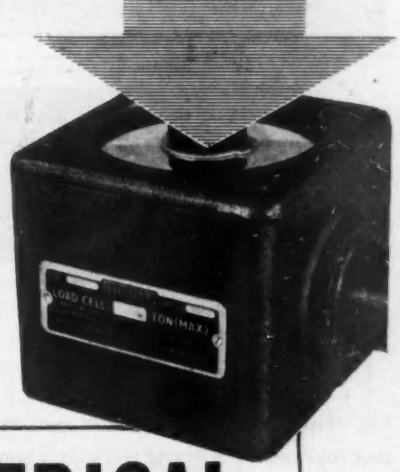

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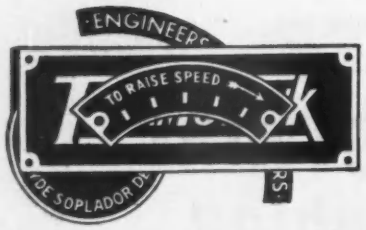

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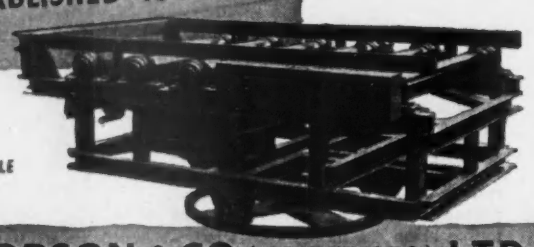

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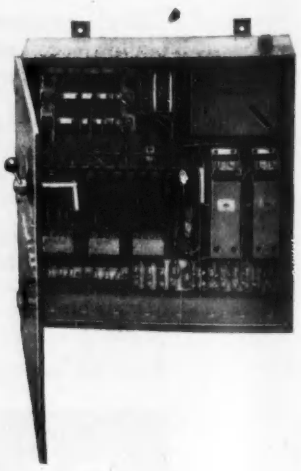

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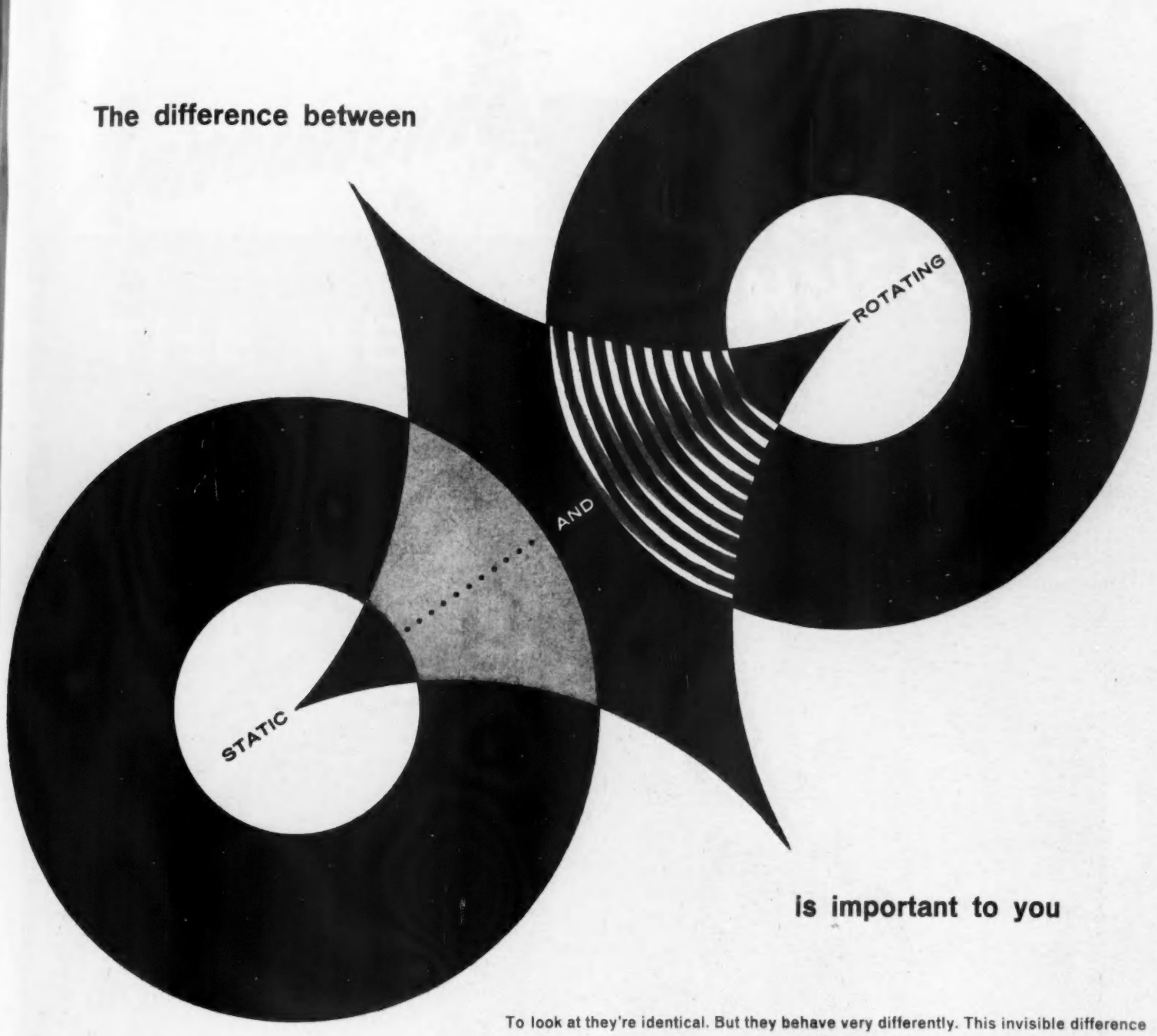

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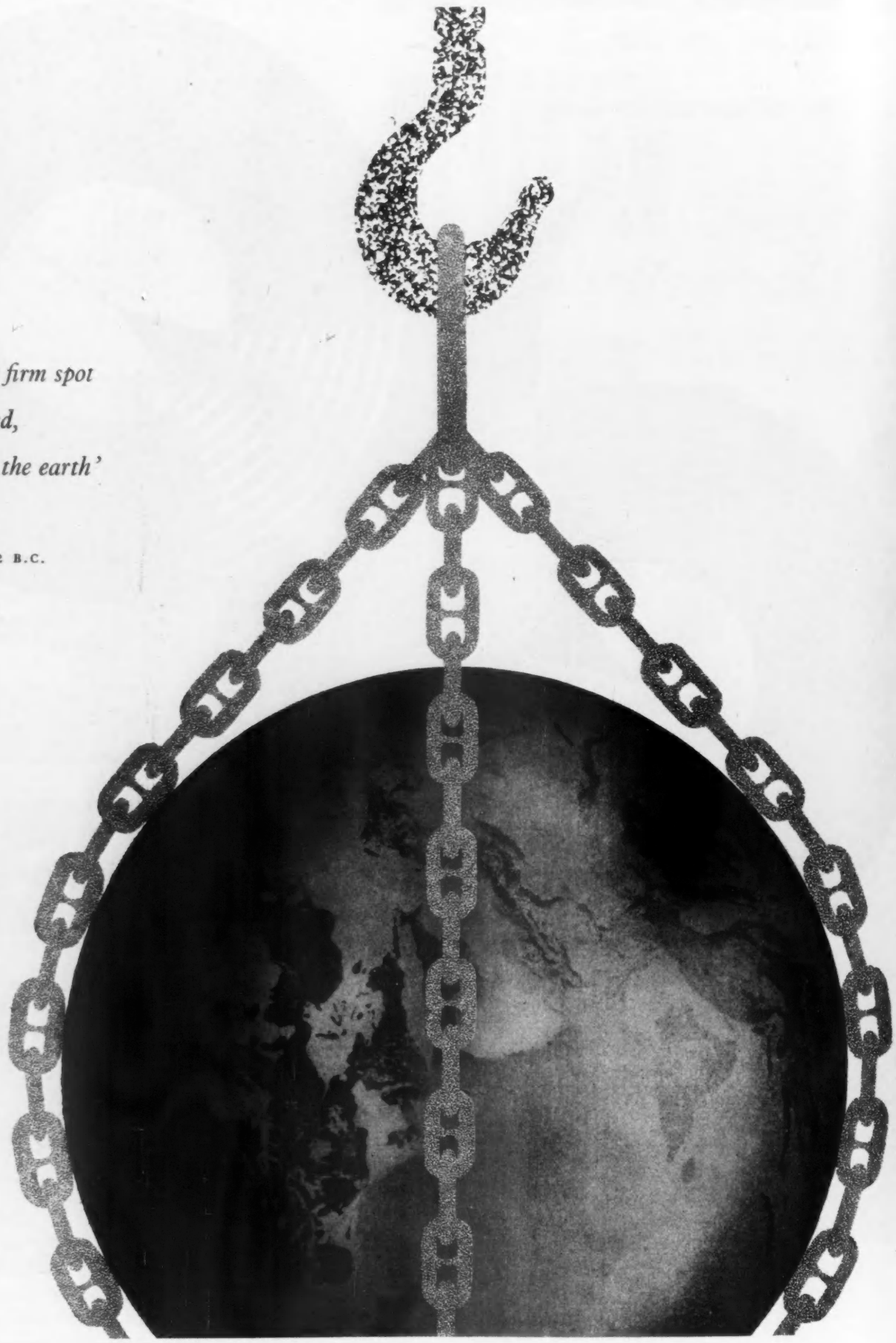

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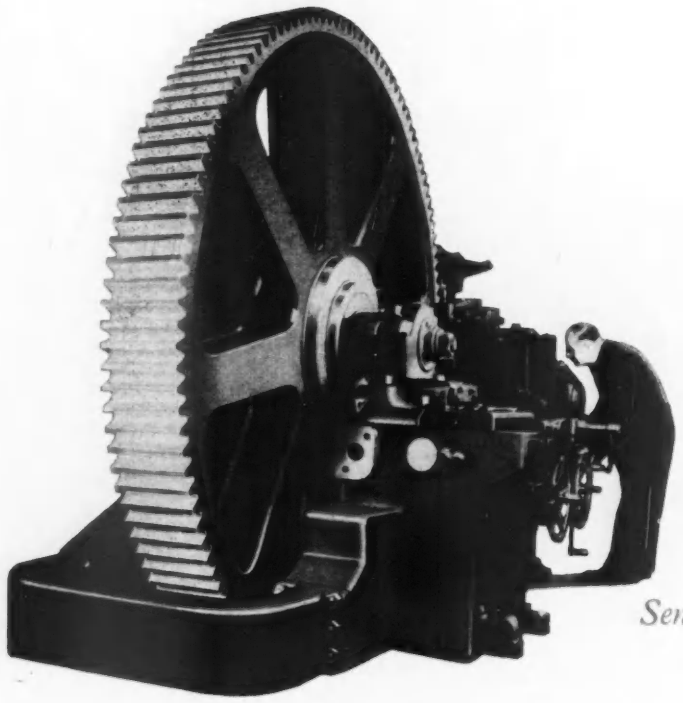

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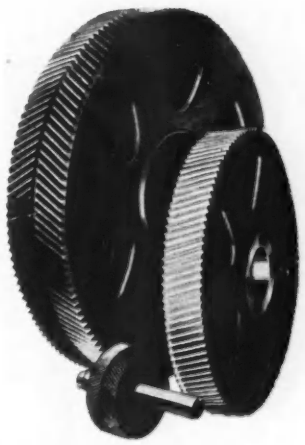

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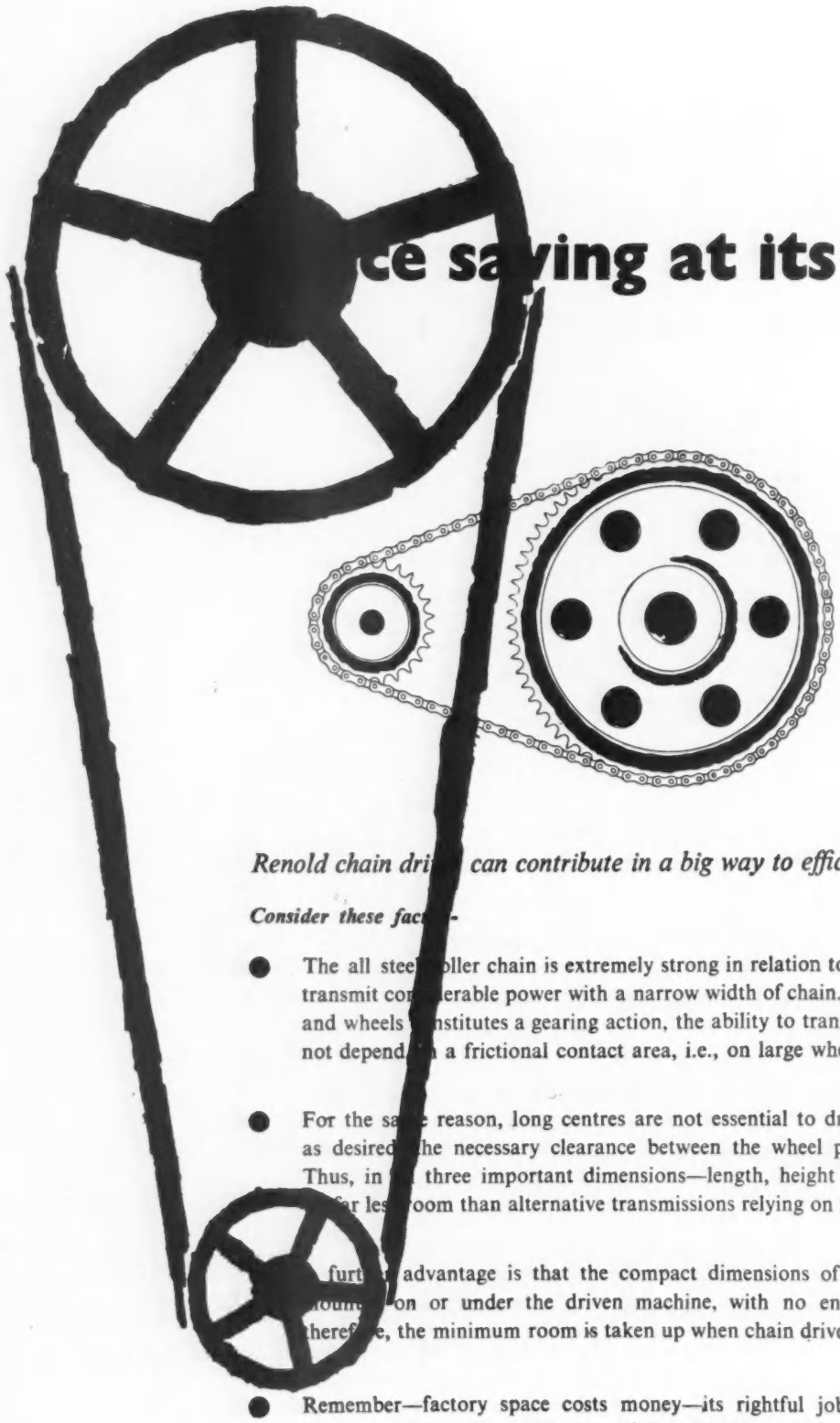

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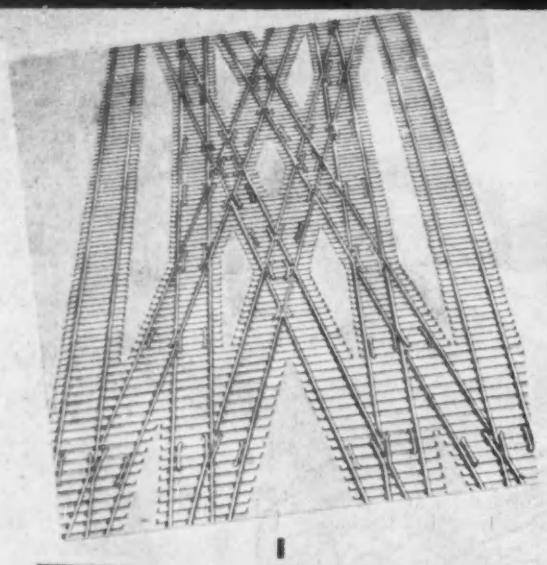

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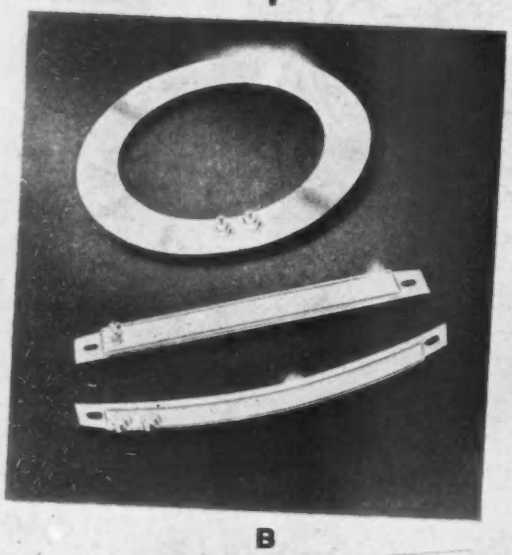

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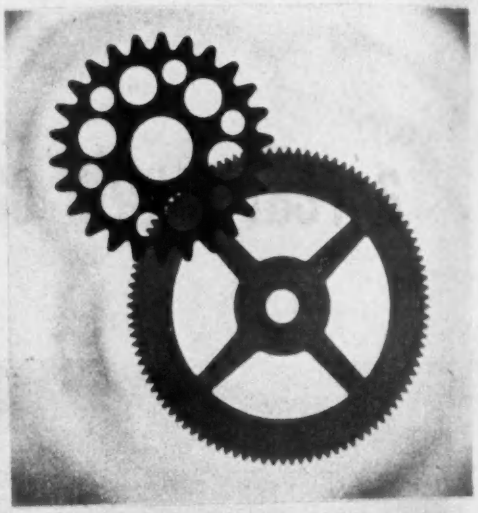

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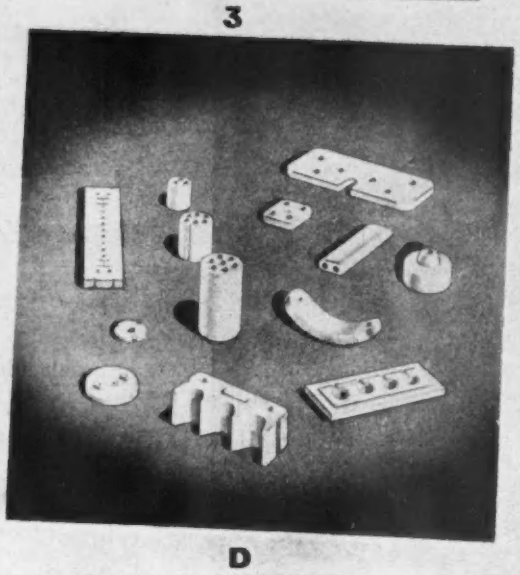

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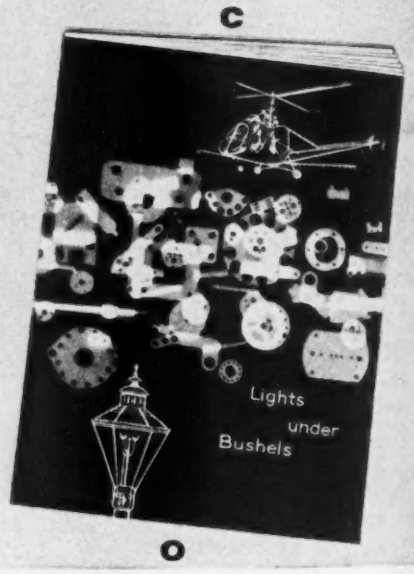

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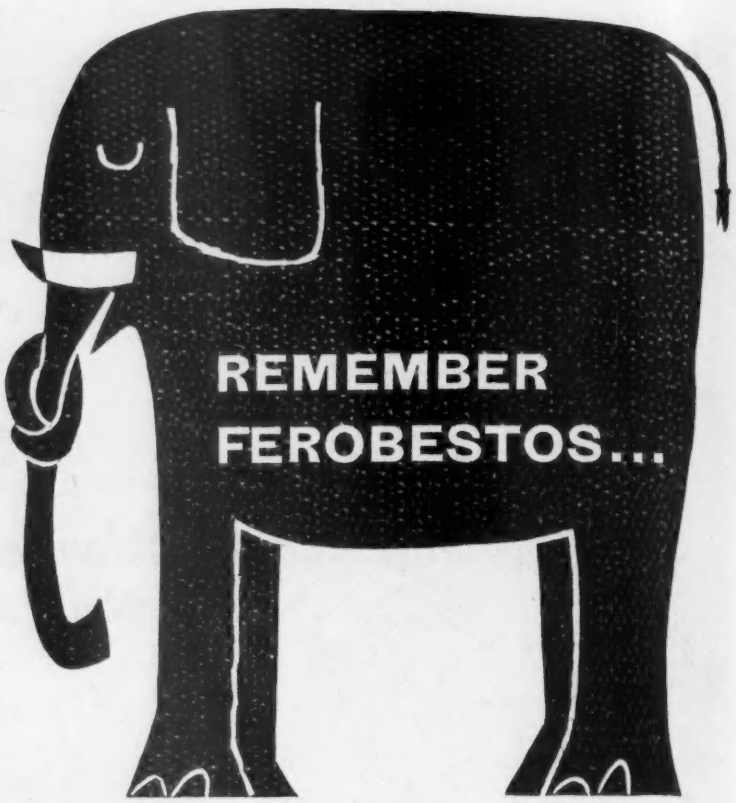

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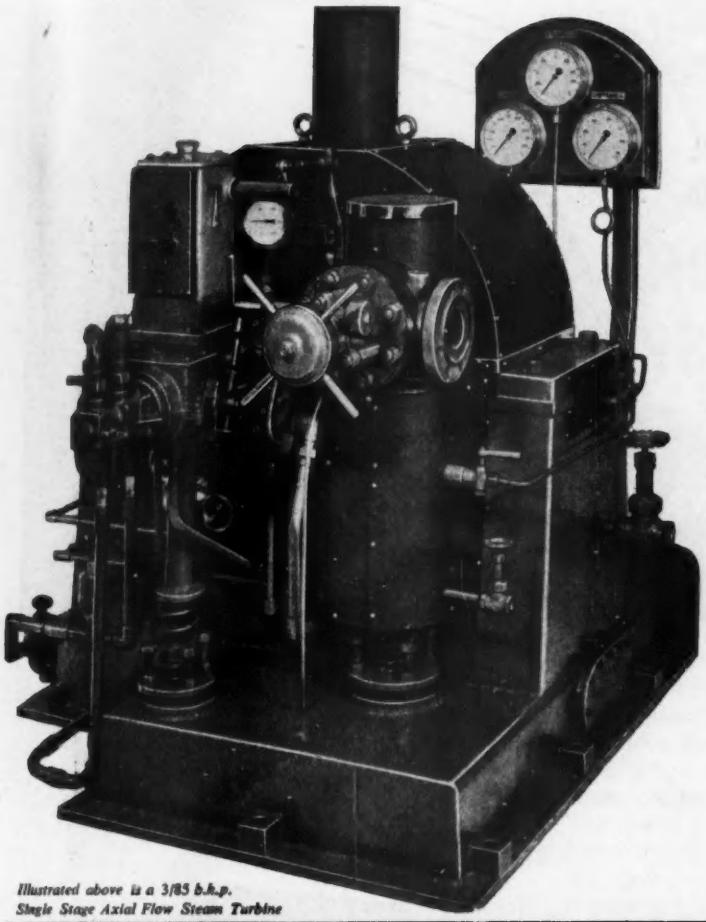

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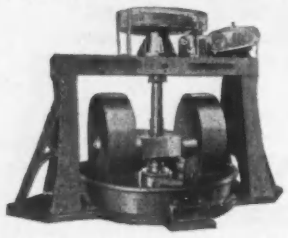

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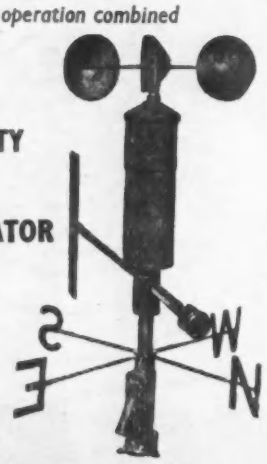

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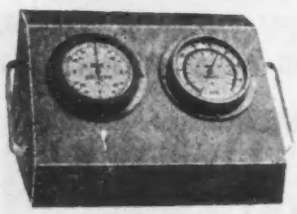

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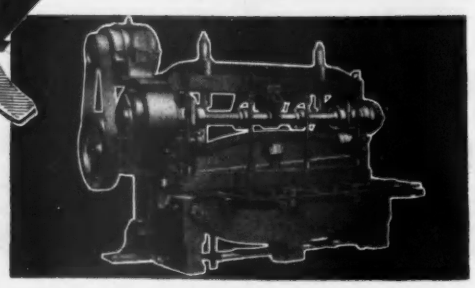

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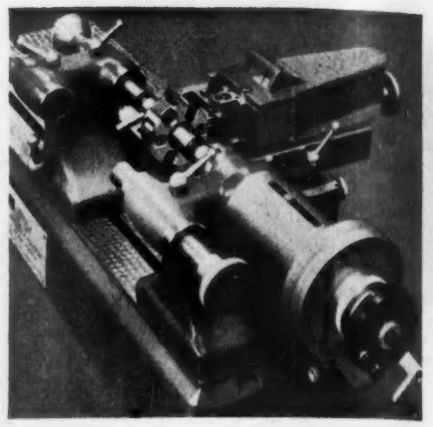

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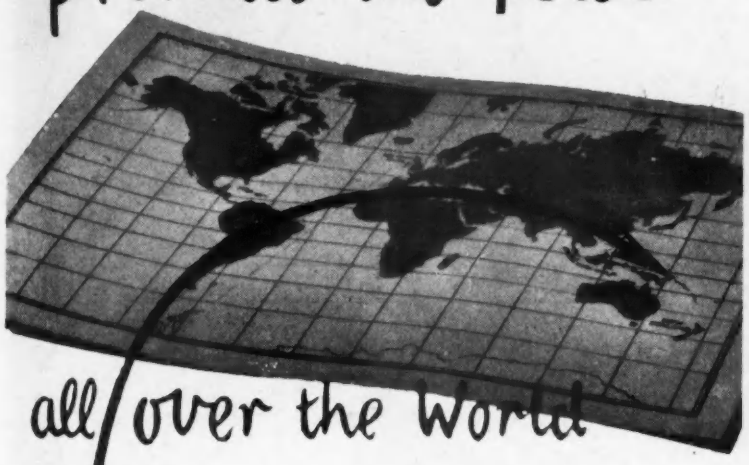

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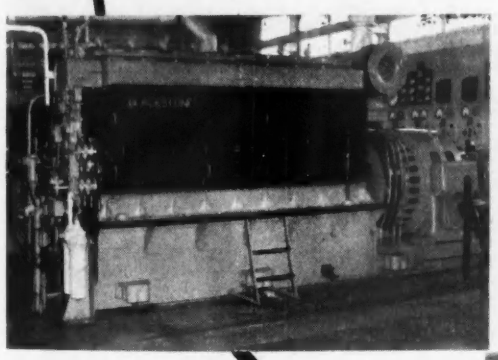

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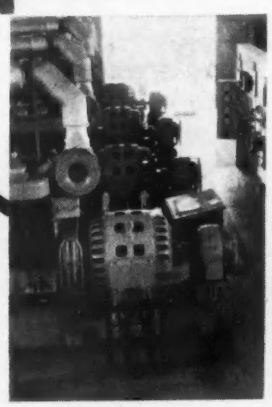

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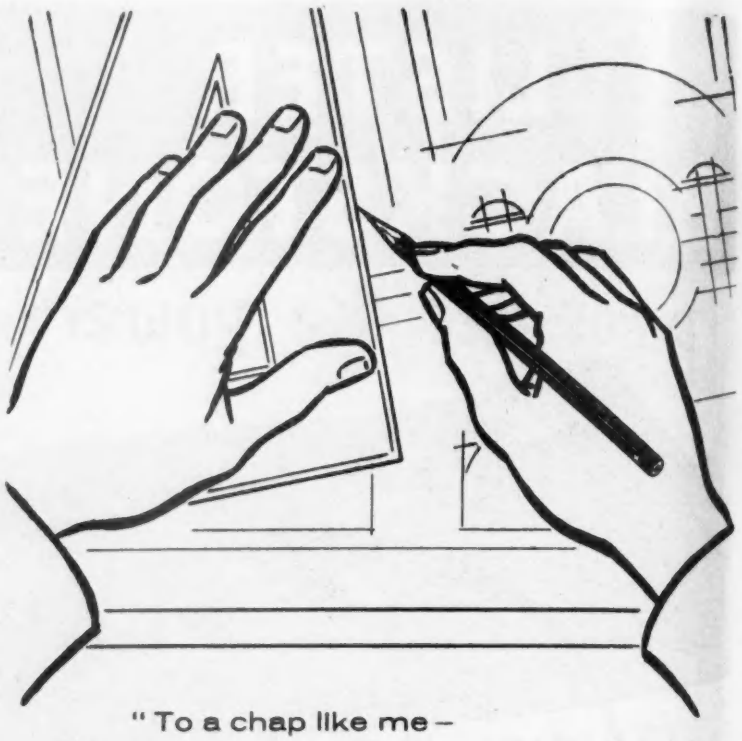

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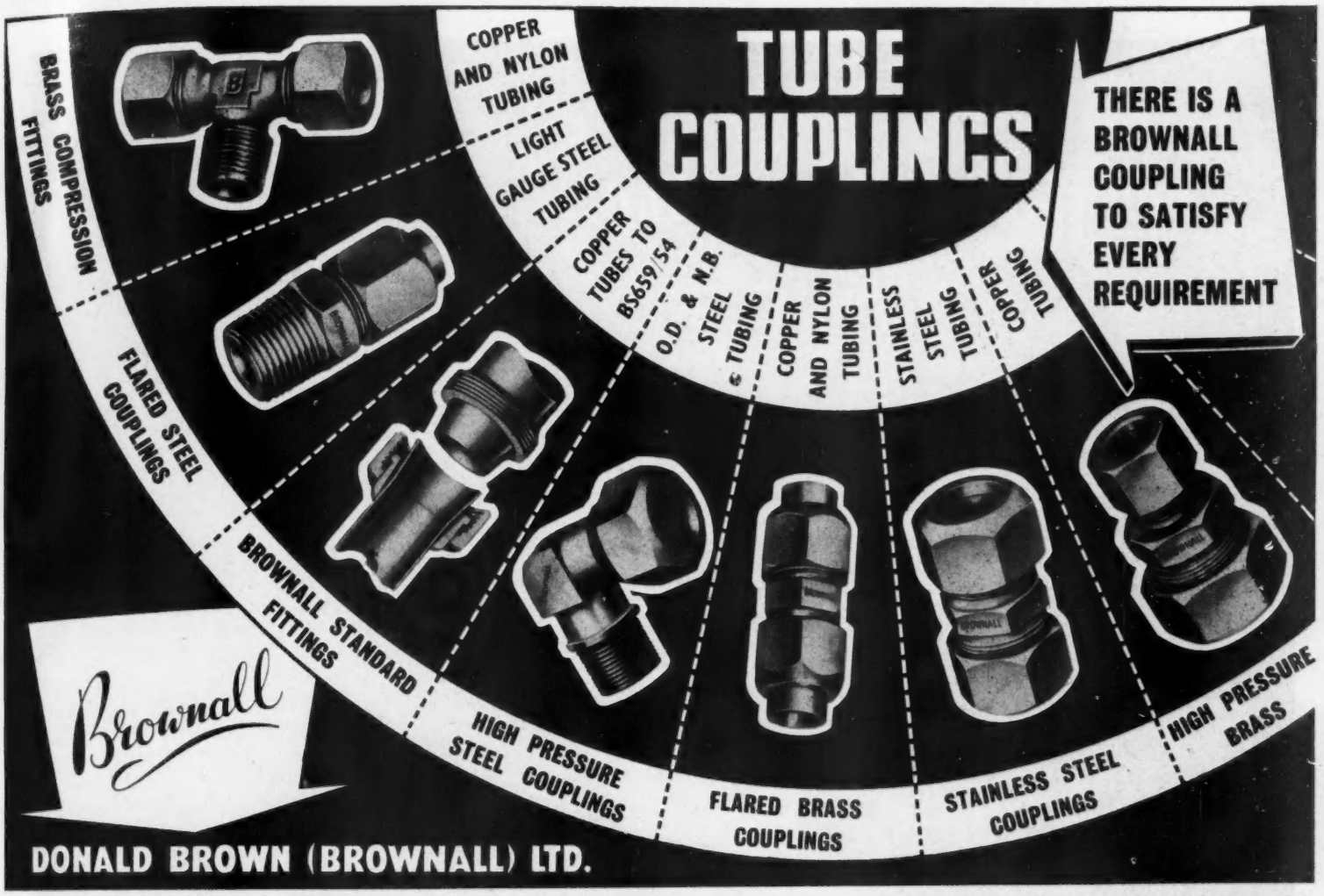

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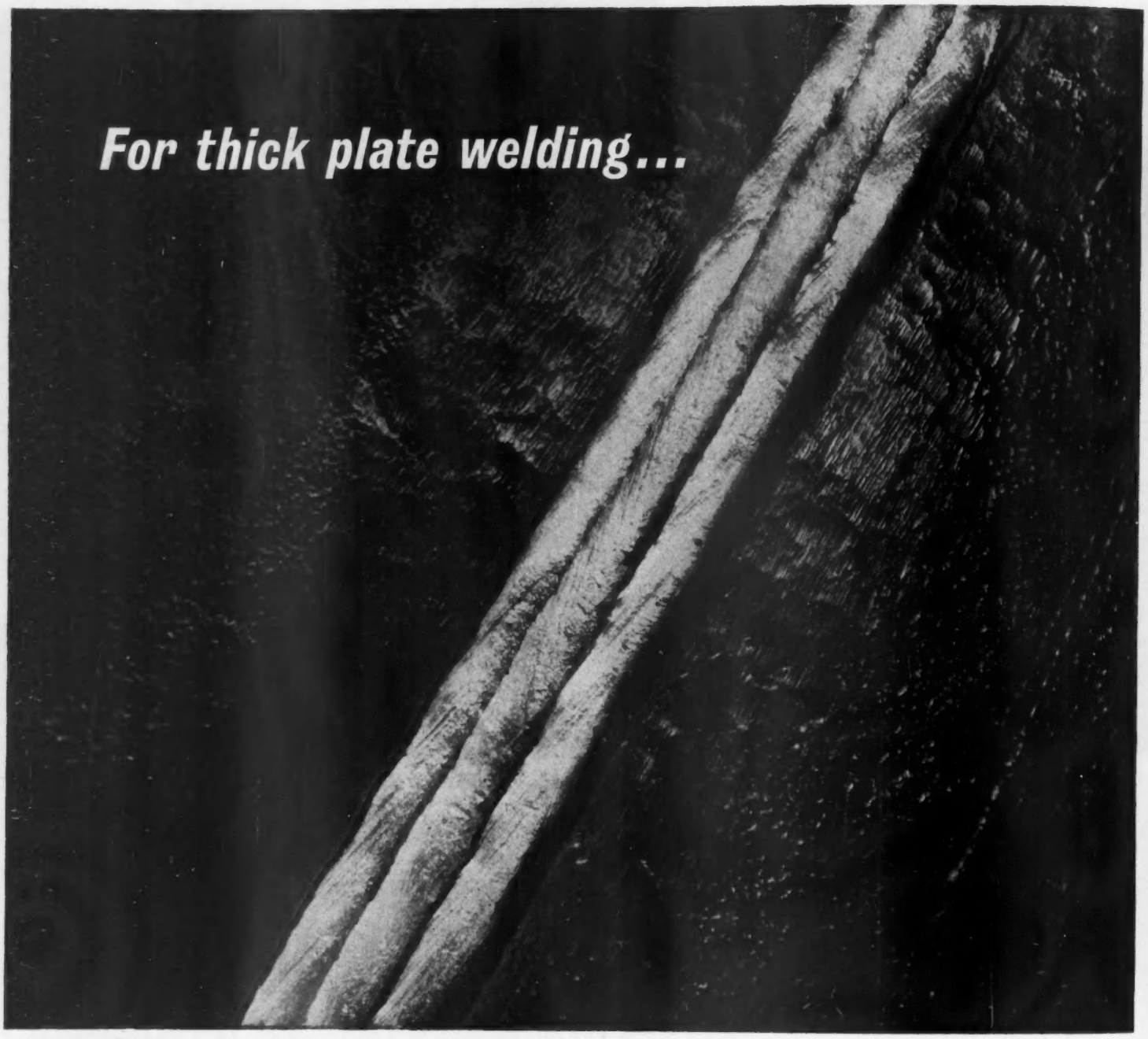

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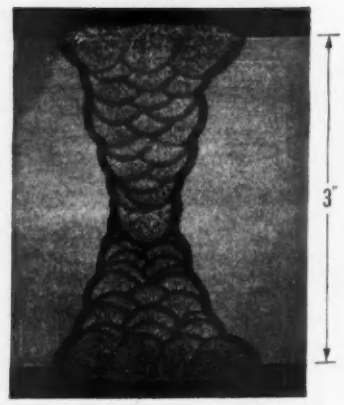

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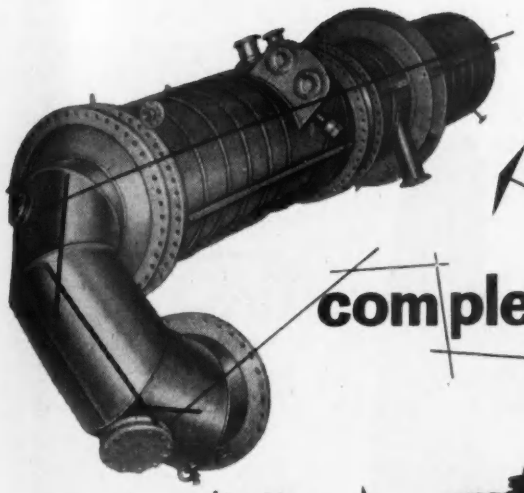

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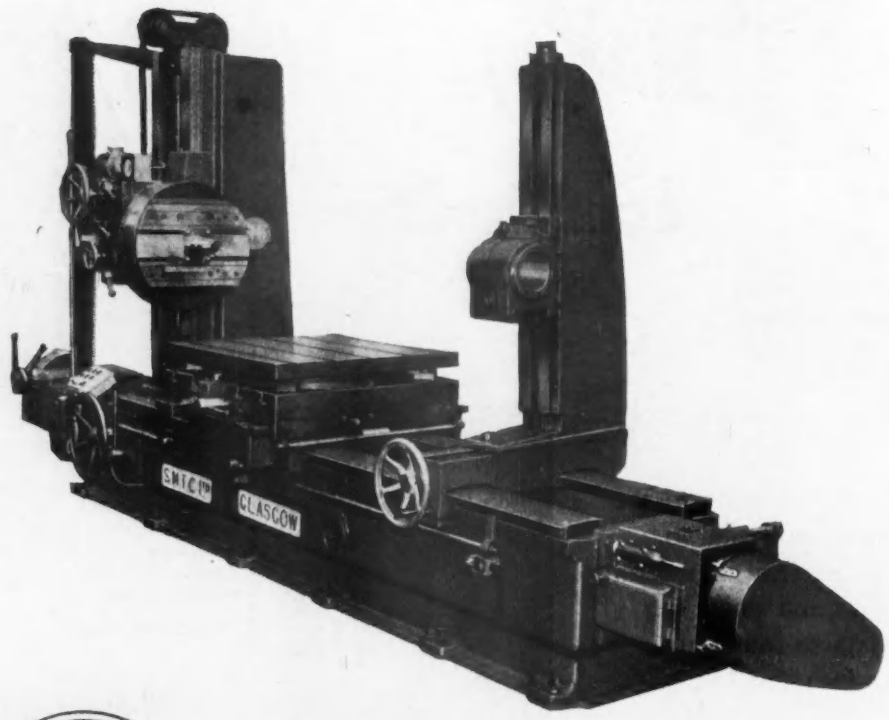

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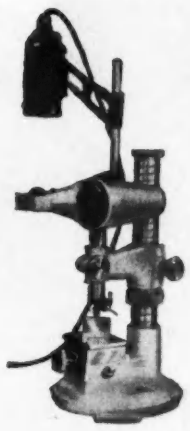

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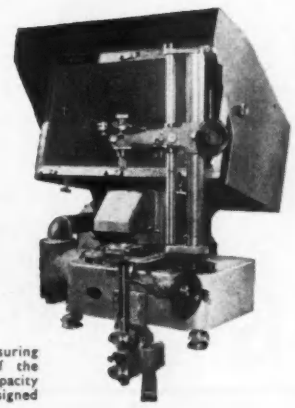
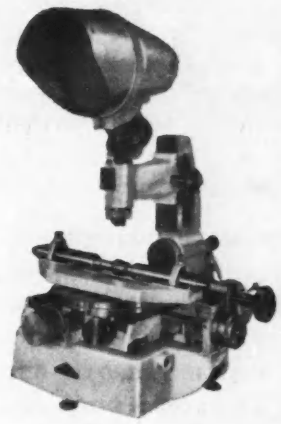


MODEL WP.100 LARGE CAPACITY UNIVERSAL PROJECTOR

Representative of the progressive policy of Optical Measuring Tools Ltd. to anticipate inspection requirements of the engineering industry, the new Model WP.100 Large Capacity Universal Projector is an extremely versatile instrument designed for both contour and surface projection.

Gauge projection lenses and condensers are turret-mounted to facilitate rapid magnification changes.
Overall sharpness and accuracy of the projected image are features of the instrument.

Magnification range 10X, 20X, 50X, 100X
Screen size 60" x 40" (1524 mm x 1016 mm)



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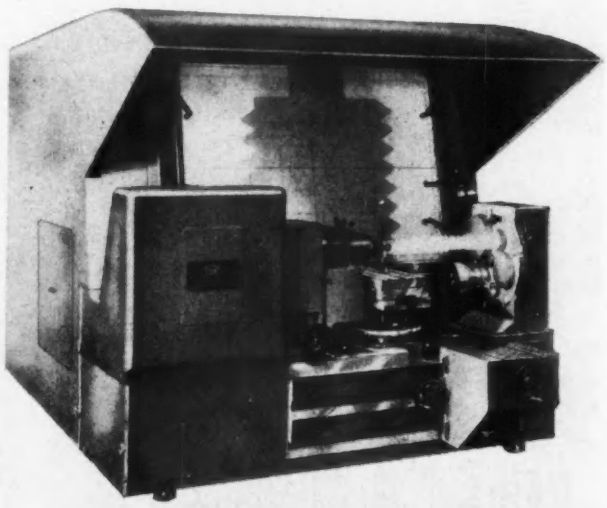

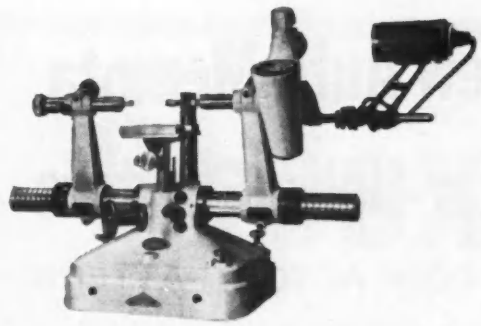

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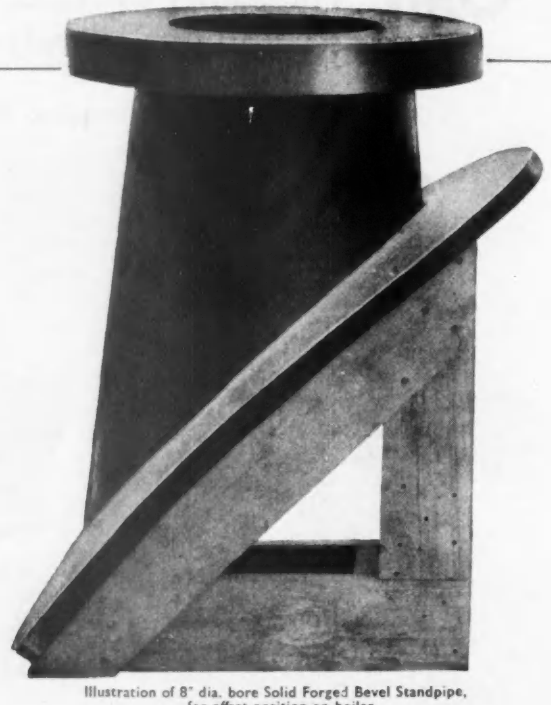

Illustration of 8" dia. bore Solid Forged Bevel Standpipe, for offset position on boiler.

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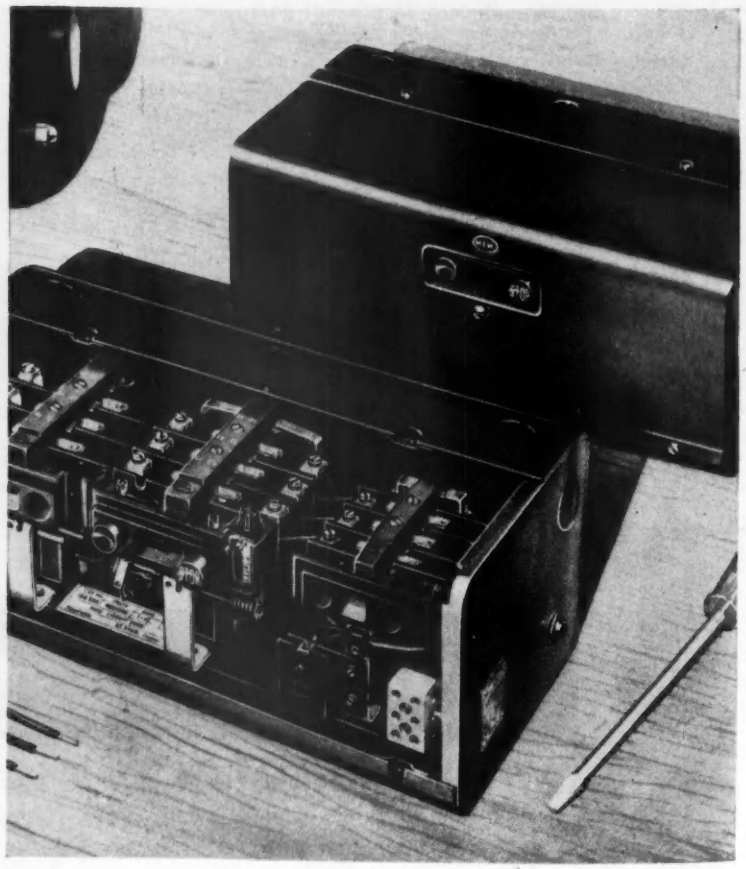
This range of "Auto-Memota" Push-Button Automatic Star-Delta Starters contains many new features developed in the M.E.M. Research Laboratory. The advanced design incorporates a three contactor switching circuit and an extremely reliable two-speed thermal changeover relay. Silver main contact studs are fitted throughout. All three contactors are mounted on a single sole-plate, to simplify wiring and facilitate inspection. The starter is enclosed in a light, yet strong sheet steel case of neat appearance, rustproofed, and finished stove grey enamel. Adequate knockouts are provided. Visual indication in the "Run" position. This new "Auto-Memota" Star-Delta Starter is designed for control of motors up to 10 H.P., 15 amp rating, 200-440 volts. Send today for List No. 416.



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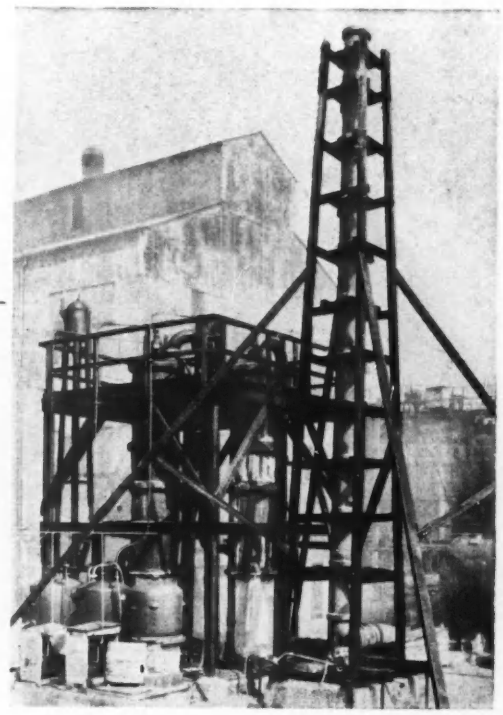
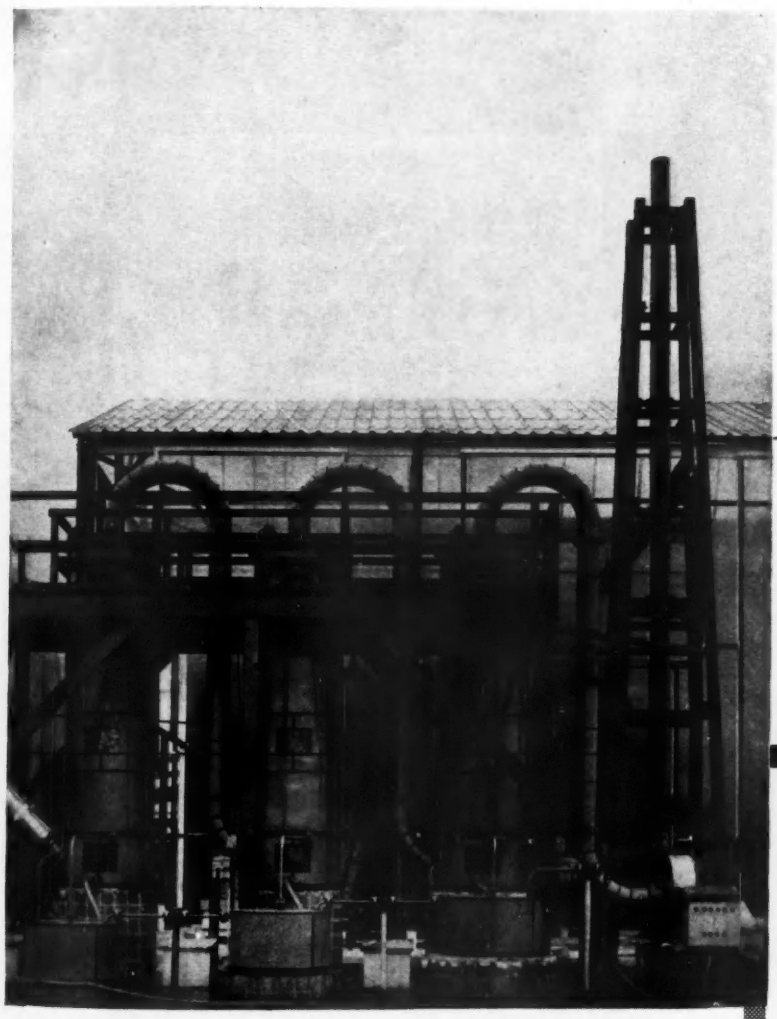
before

The original ceramic nitric acid fume scrubbing towers at the Brantham Works of BX Plastics Ltd.





and after

the new fume scrubbing installation at Brantham, with towers and ducting entirely constructed of COBEX sheet.

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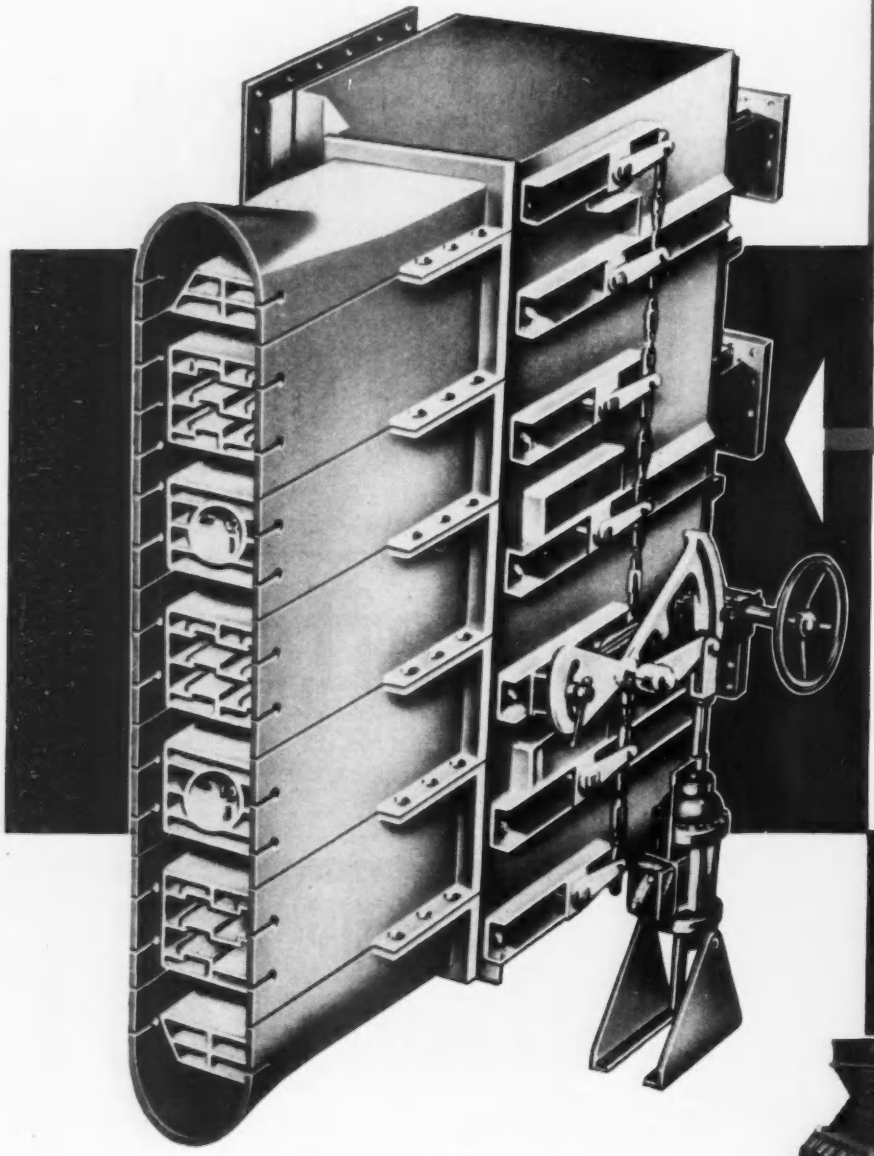
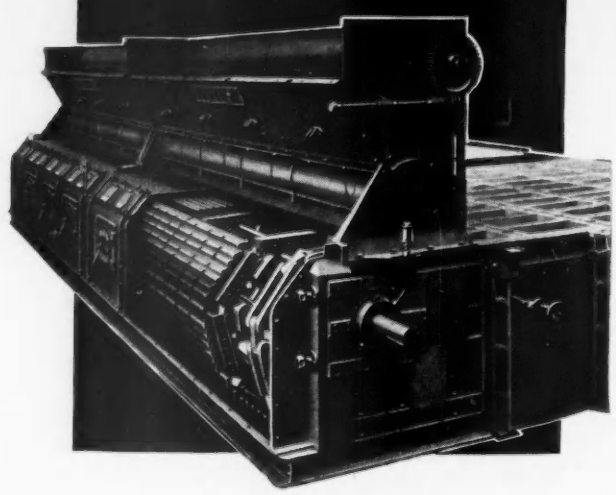


Burner
or
Stoker?



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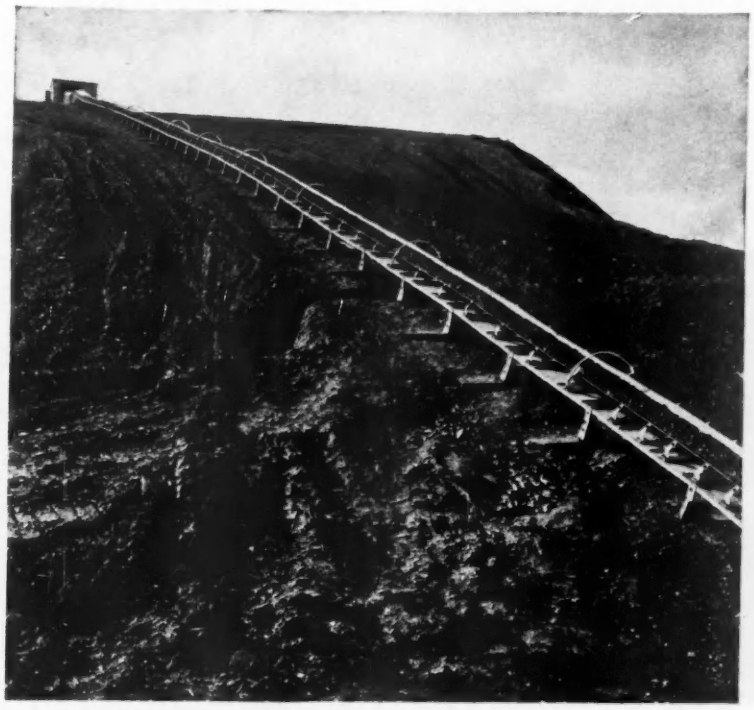
A variable plate feeder, shown at foot, is fed from an existing hopper to a fully troughed standard belt conveyor 500 ft. long driven by a Goliath 6 head complete with fluid coupling and brake. Standard loop take up gear to store 60 ft. of belting, provides for extension of the main conveyor.

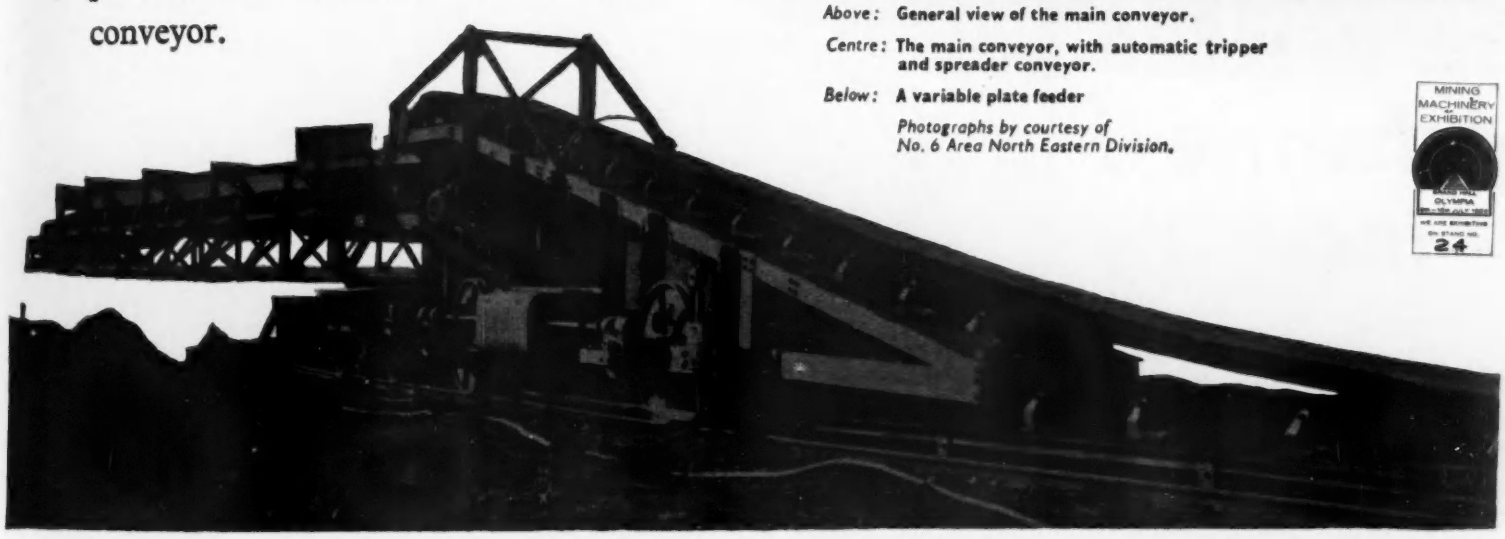


Above: **General view of the main conveyor.**

Centre: **The main conveyor, with automatic tripper and spreader conveyor.**

Below: **A variable plate feeder**

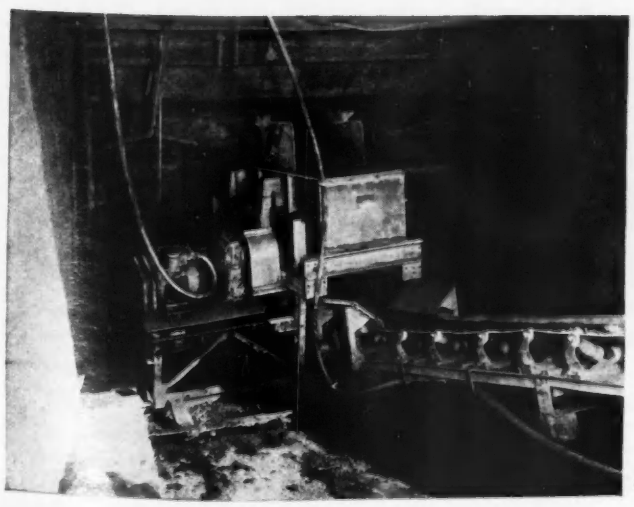
Photographs by courtesy of No. 6 Area North Eastern Division.



MINING MACHINERY EXHIBITION OLYMPIA 24

Installed on an existing heap, the main Conveyor is on a gradient of 1 in 3½ against. Initially, the main Conveyor is extending the heap forward by means of a travelling tripper and radial spreader conveyor. Eventually a further cross conveyor 225 ft. long will be installed at right-angles to the main Conveyor and the tripper and spreader will be transferred to the cross conveyor, so that the heaps can then extend on a 225 ft. wide front.

Write for a copy of publication EN21 which describes Sutcliffe's surface conveyor installations



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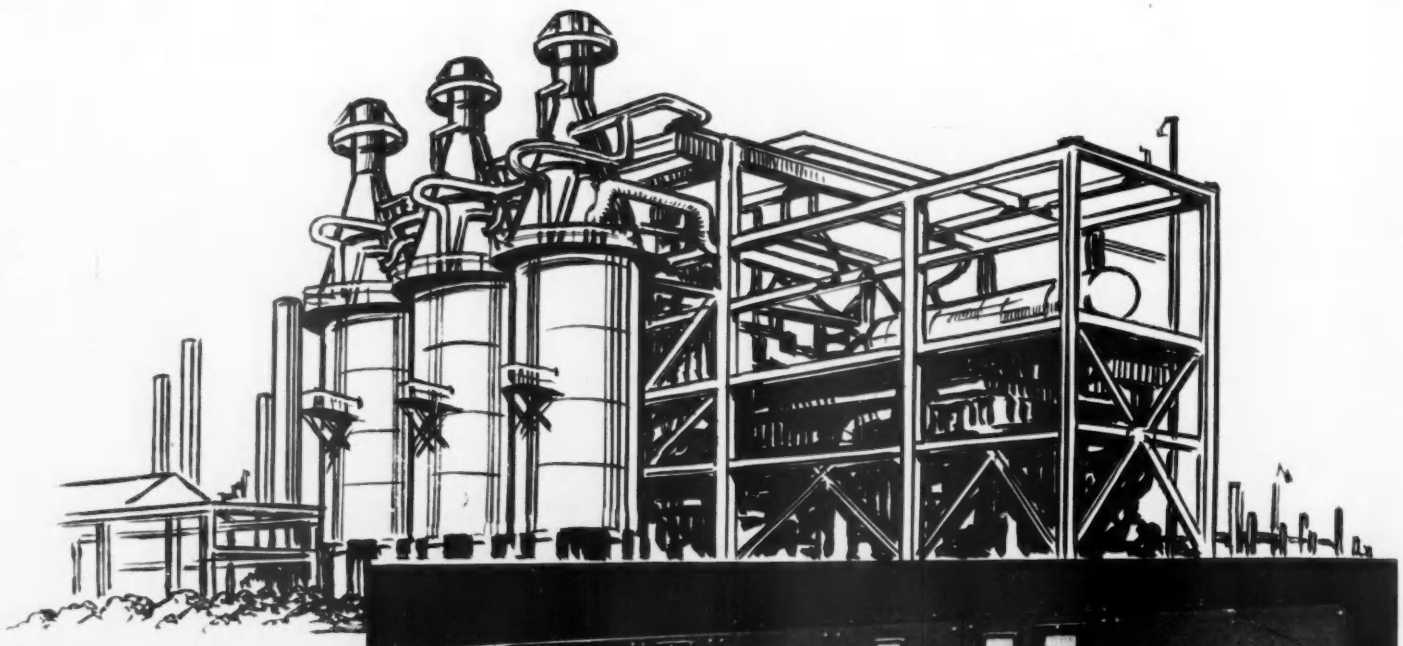

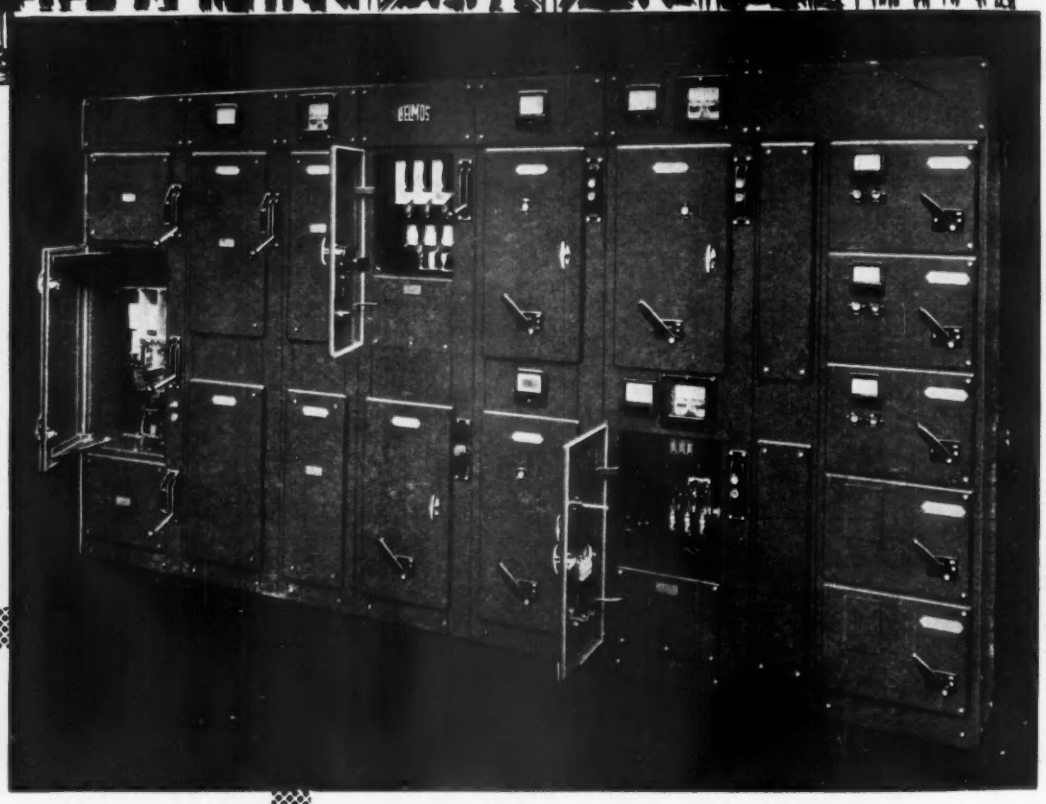

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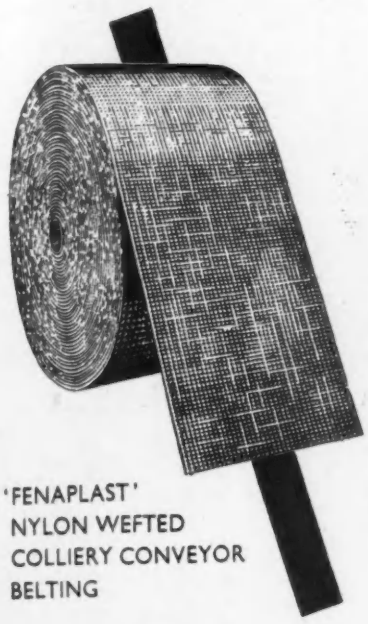

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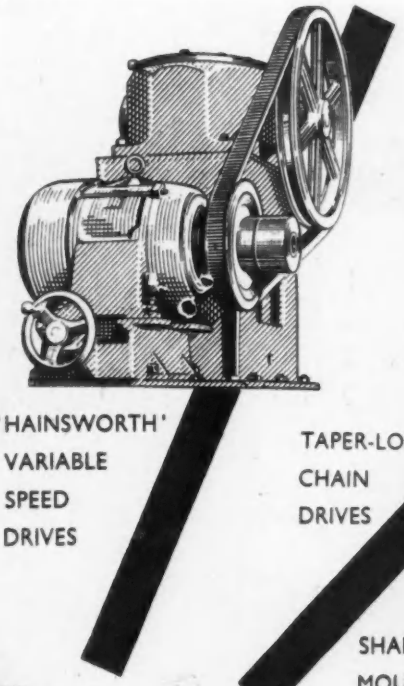

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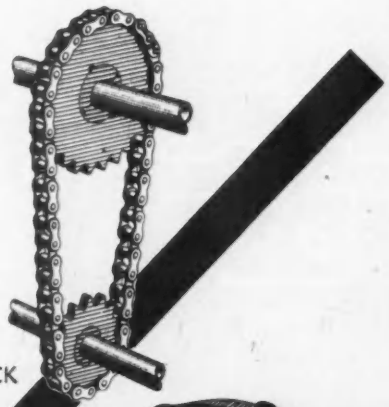

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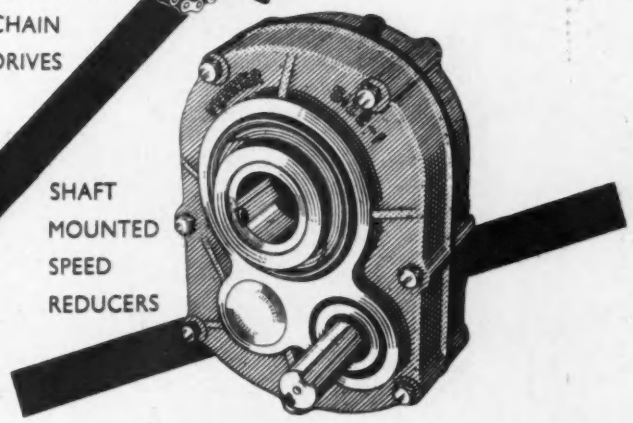
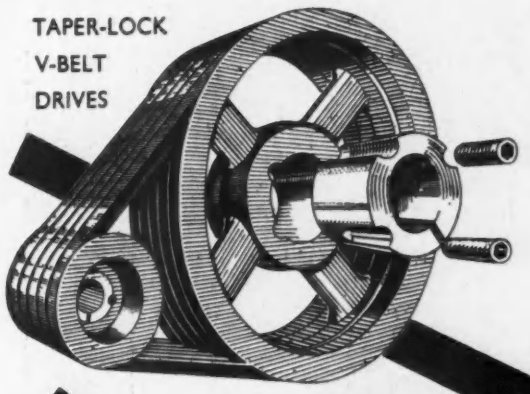


SHAFT MOUNTED SPEED REDUCERS



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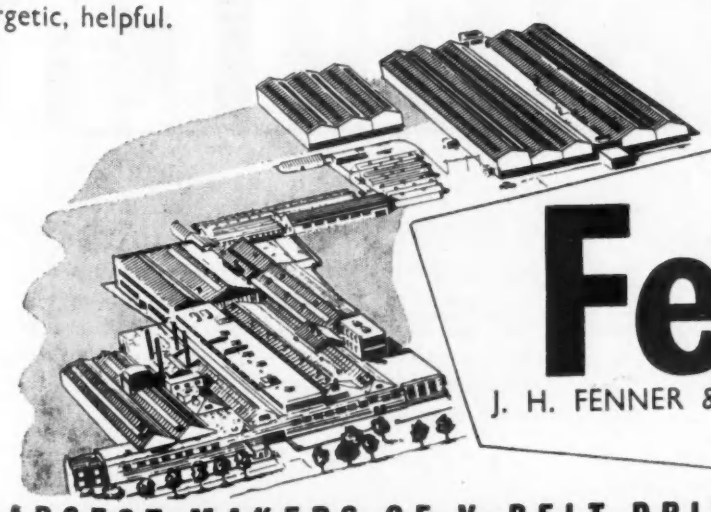

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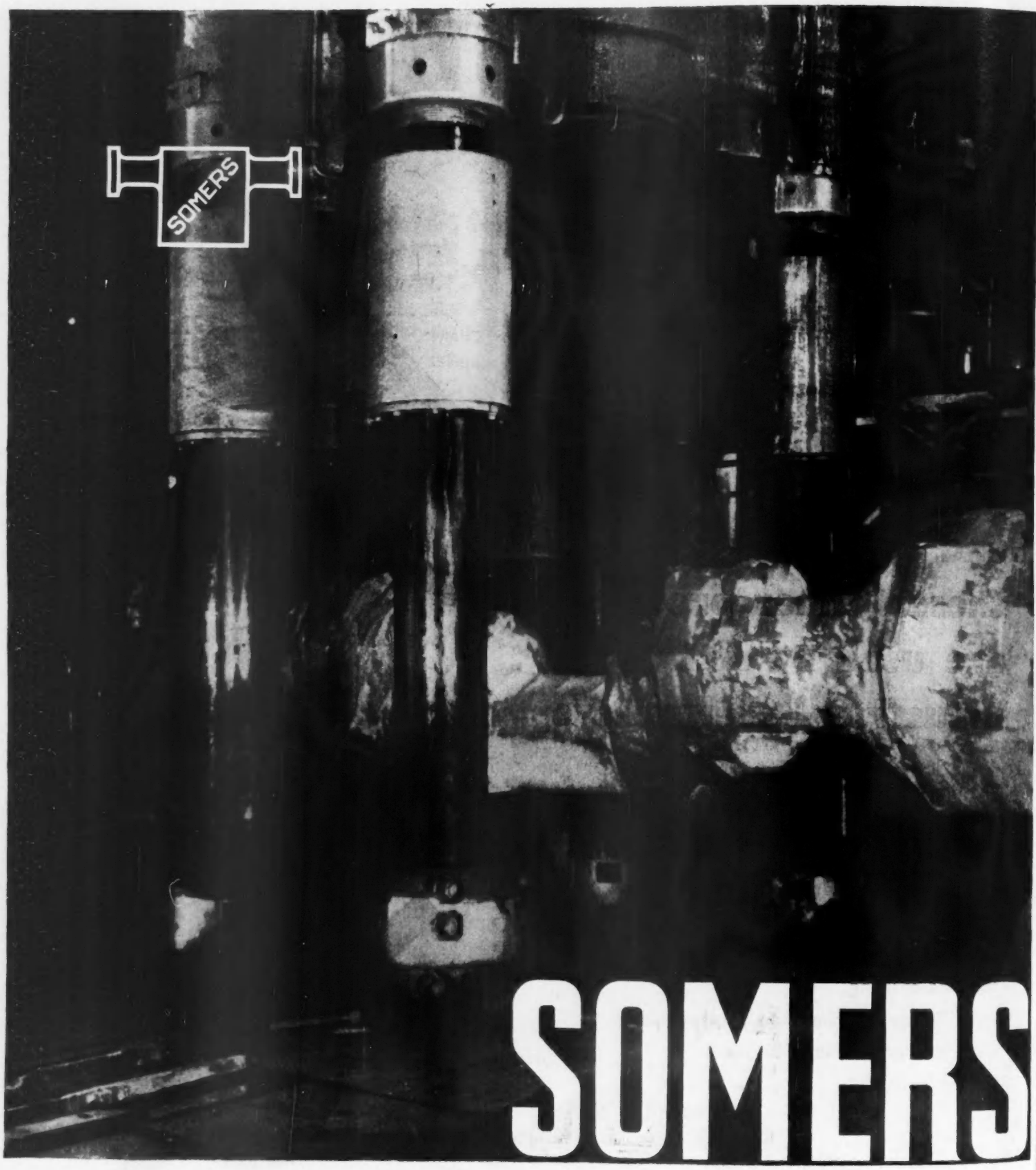

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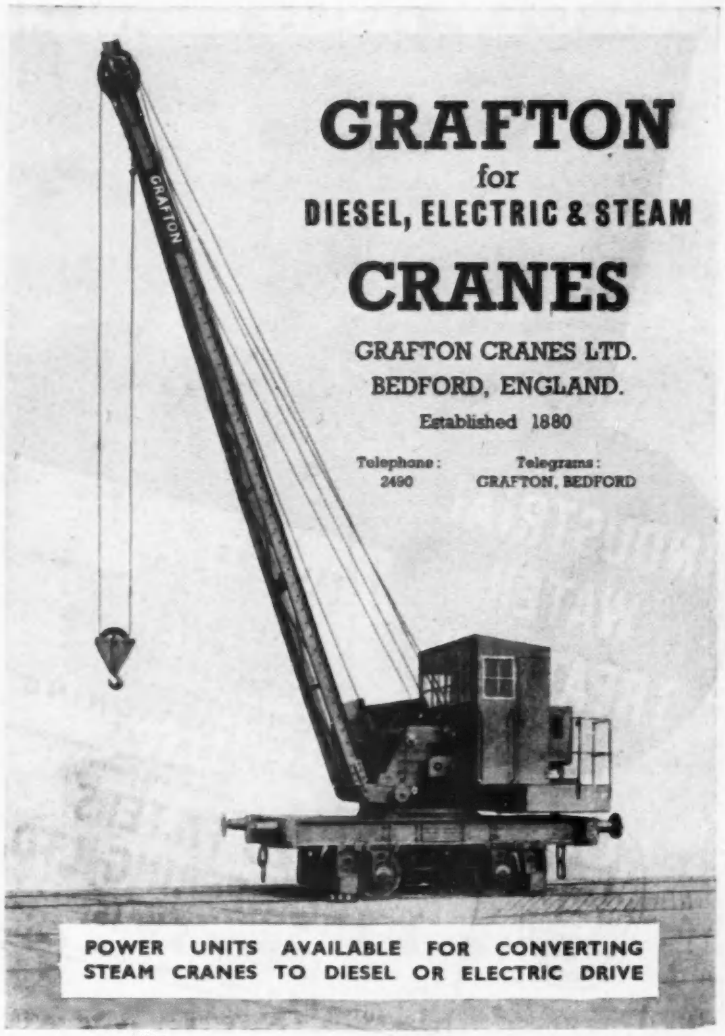

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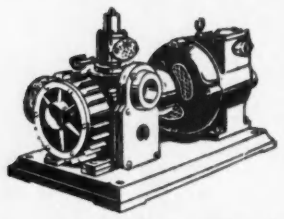

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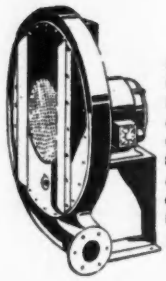

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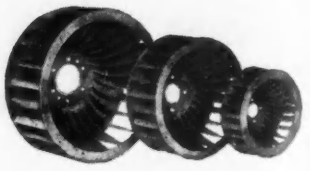

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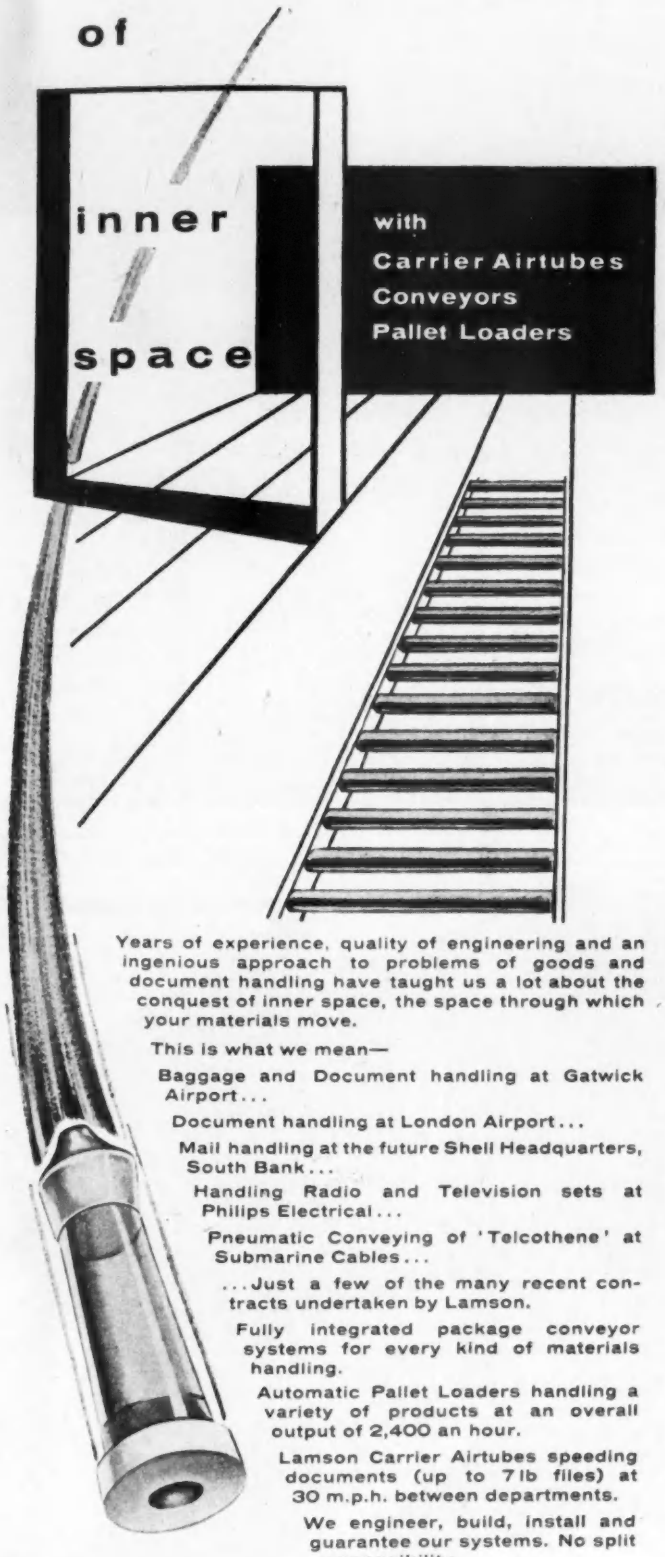

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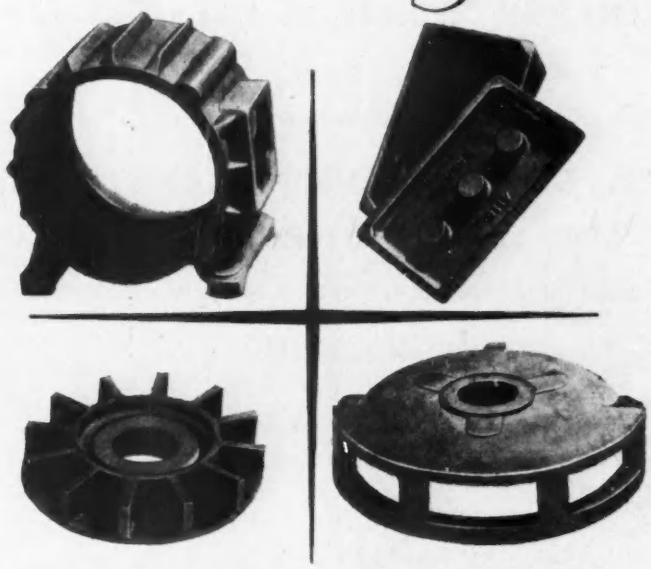

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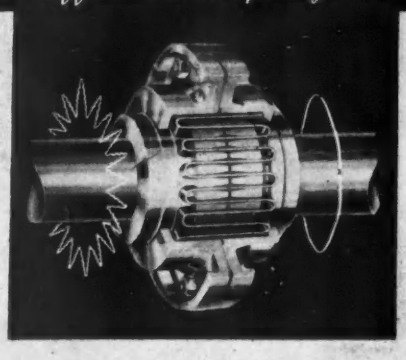

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Over 50 years experience embodied in design and manufacture

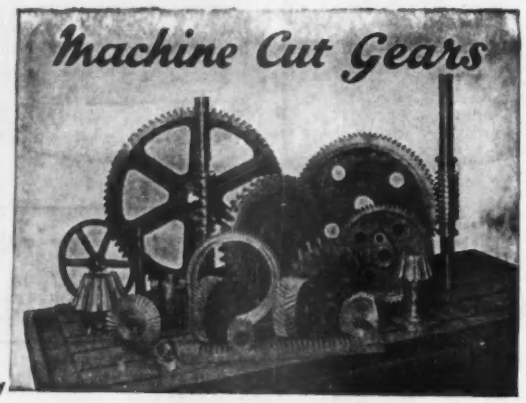
ST. GEORGES ENGINEERS LTD.,

ORDSALL LANE, MANCHESTER 5

Telephone: TRAfford Park 1207 (4 lines) *Telegrams: "Georgic" Manchester 5*

IG

SPURS
BEVELS
WORM WHEELS
HELICALS
CHAIN GEARS
Complete Supply Cutting Only



WORMS
RACKS
SCREWS
SILENT GEARS
CHANGE GEARS
All materials standard pitches to 7ft diameter

General machine castings made to customers' patterns. Low prices for planing, boring, turning, screwcutting
Send your enquiries to

GREENWOOD'S STANDARD GEAR CUTTING CO. LTD.,

New Bond Street, Halifax. *Telephone: Halifax 5217/8* *Telegrams: "Gears."*

Mechanised Handling

This kind of plant is almost as beneficial to your customers as it is to you. They can be sure you are delivering to specification and with greater speed. Lorries are loaded in a matter of seconds and kept on the road. You save your own time as well as theirs and the quality of the product is mechanically assured. This type of plant can be designed and adapted to your needs, whilst allowing for any special conditions of site or working.

NIAGARA

SCREENS (Gt. Britain) LTD.

STRAYSFIELD ROAD, CLAY HILL, ENFIELD, MIDDLESEX.

Telephone: ENField 6622 (4 lines)

Sole manufacturers of

"TENEMAX"

Regd. TRADE MARK

PIANO WIRE SCREENING SURFACES

The solution to damp and difficult materials.
No heating required.
Fullest particulars on request.

SHEETS · PLATES · SECTIONS
BRIDGE RAILS · IRON AND STEEL MERCHANT BARS
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HOOPS AND STRIP · ETC.

SHEARING · COLD SAWING & PROFILE CUTTING IN ALL THICKNESSES AND SHAPES.

HALL BROS

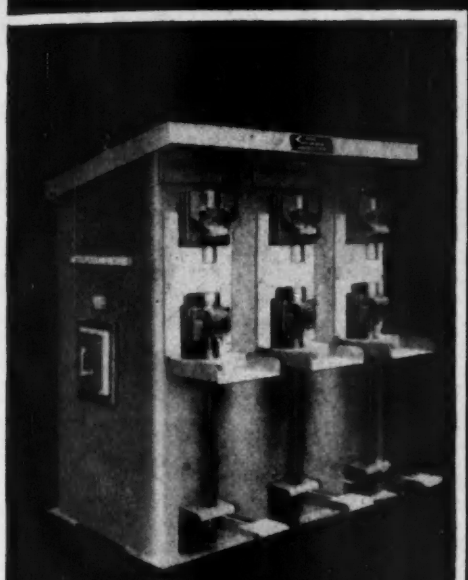
(WEST BROMWICH) LTD

EAGLE WORKS · GREETS GREEN

WEST BROMWICH

TELEPHONE:* TIPTON 1611 · *10 LINES

No wait ... no waste with METROVICK RIVET HEATERS



Hot rivets are always ready at a few seconds' notice with Metrovick resistance heating machines. The system is economical too, since the use of current is confined to periods of actual heating.

Both single and multi-head types are simple to operate and require little maintenance apart from electrode dressing. The electrodes are quickly adjustable and, in multi-head types, separate transformers are used so that rivets of different sizes can be heated simultaneously.

Heat is concentrated in the shanks whilst the heads of the rivets remain comparatively cool; full visibility during heating reduces the risk of burning. The machines are of strong, drip-proof construction enabling them to be used in semi-exposed positions.

CHARACTERISTIC DATA *(Applicable to each head)*

Equivalent continuous rating (kVA)	10	17	25
Maximum input in normal operation (kVA)	15	25	35
Normal heating range for M.S. rivets	$\frac{5}{16}$ in. x 1 in. to $\frac{7}{8}$ in. x 4 in.	$\frac{3}{8}$ in. x $1\frac{1}{4}$ in. to $1\frac{1}{8}$ in. x 4 in.	$\frac{3}{8}$ in. x $1\frac{1}{2}$ in. to $1\frac{1}{4}$ in. x 6 in.
Average output in lb. per hour	40	65	90

A Metrovick three-head Electric Resistance Rivet Heater

A Metrovick single-head electric rivet heater in use for heating rivets for a 150-ton crane at the Winsford, Cheshire, factory of Messrs. Henry Smith & Company Limited

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER, 17
An A.E.I. Company

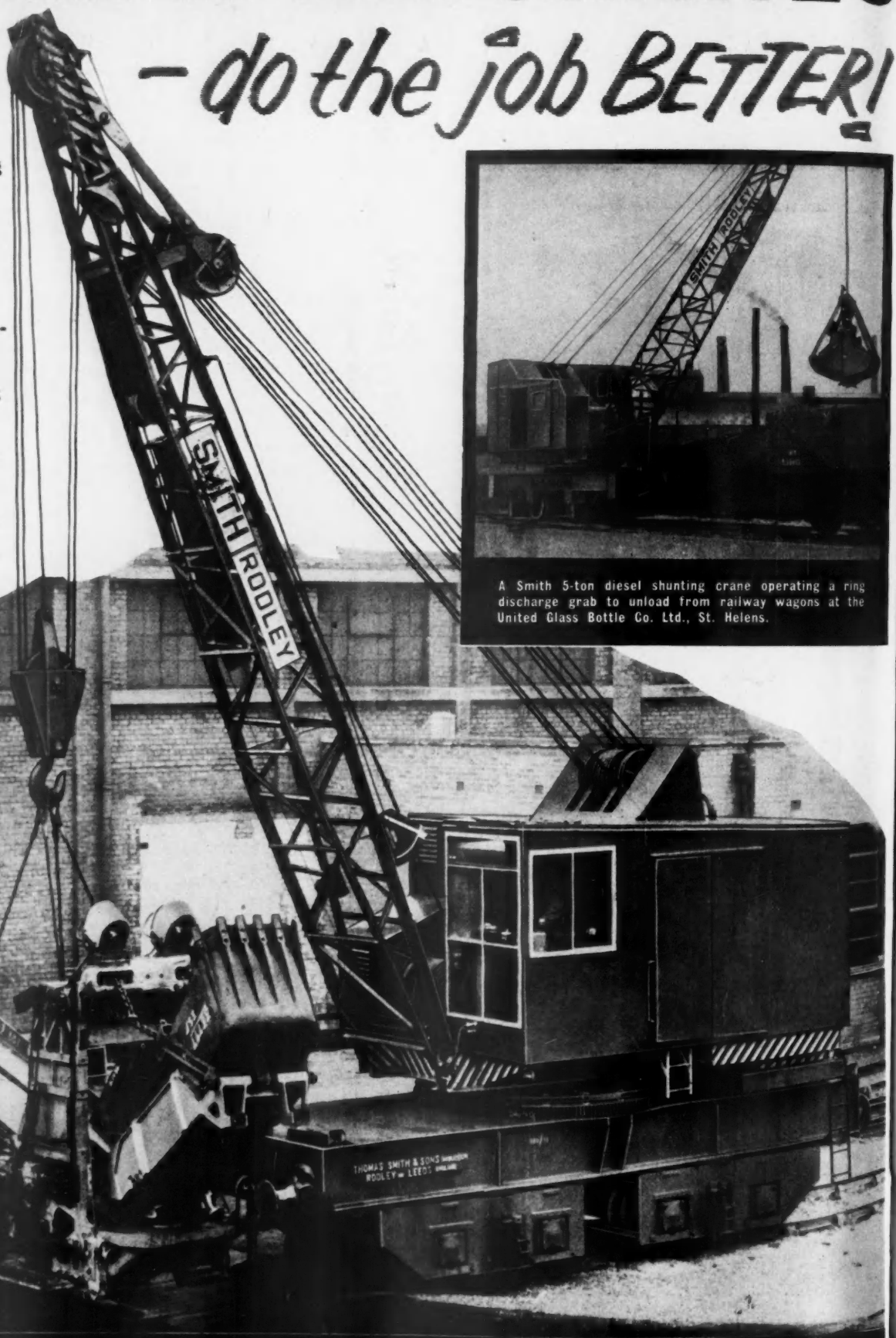
L/W806

SMITH CRANES

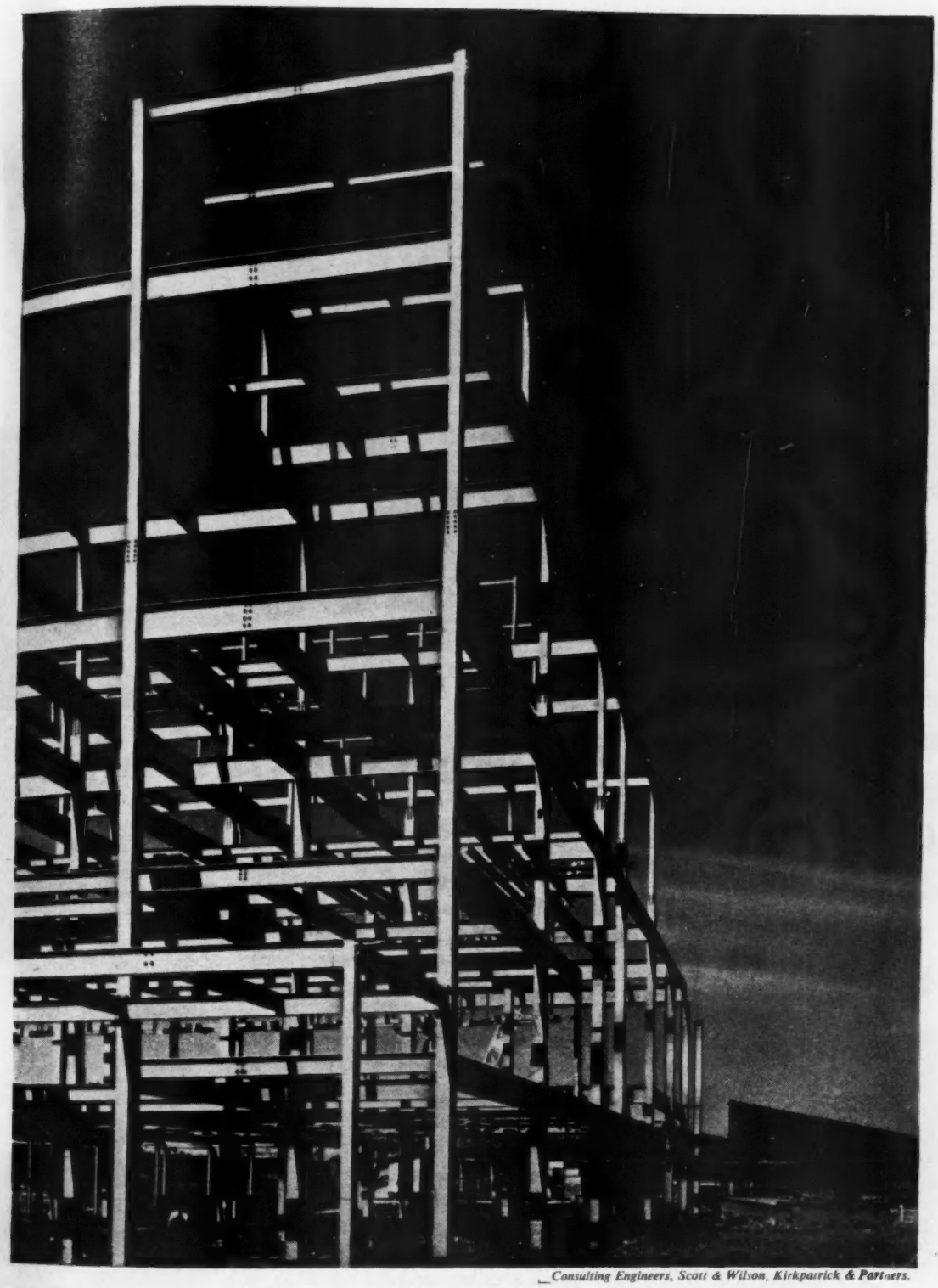
– do the job BETTER!

Smith Cranes employ the newest forms of power and are serving the biggest names in industry, both in the United Kingdom and overseas. Typical of Smith's modern productions is this 25-ton diesel-electric shunting crane, supplied to the Distington Engineering Co. Ltd., shown manoeuvring a large unit of tunnelling mechanism.

A Smith 5-ton diesel shunting crane operating a ring discharge grab to unload from railway wagons at the United Glass Bottle Co. Ltd., St. Helens.



THOMAS SMITH & SONS (RODLEY) LTD · CRANE & EXCAVATOR WORKS · RODLEY · LEEDS



Consulting Engineers, Scott & Wilson, Kirkpatrick & Partners.

Part of the steel framed structure supplied to British Nylon Spinners (Australia) Pty. Ltd. for their new factory at Melbourne.

BRAITHWAITE & CO. ENGINEERS LIMITED

BRIDGE AND CONSTRUCTIONAL ENGINEERS

LONDON OFFICE: DORLAND HOUSE · REGENT ST · LONDON SW1 · TEL: WHITEHALL 3993

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GREY IRON
ALUMINIUM
NON-FERROUS
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MACHINED ASSEMBLIES

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Manufacturers of Mild Steel
CRANE BLOCKS
SINGLE AND MULTIPLE SHEAVE
TACKLE BLOCKS
& PATENT SNATCH BLOCKS
FOR WIRE ROPE

ILLUSTRATED LISTS
ON REQUEST

Telephone: Cardiff 23641 (5 lines)

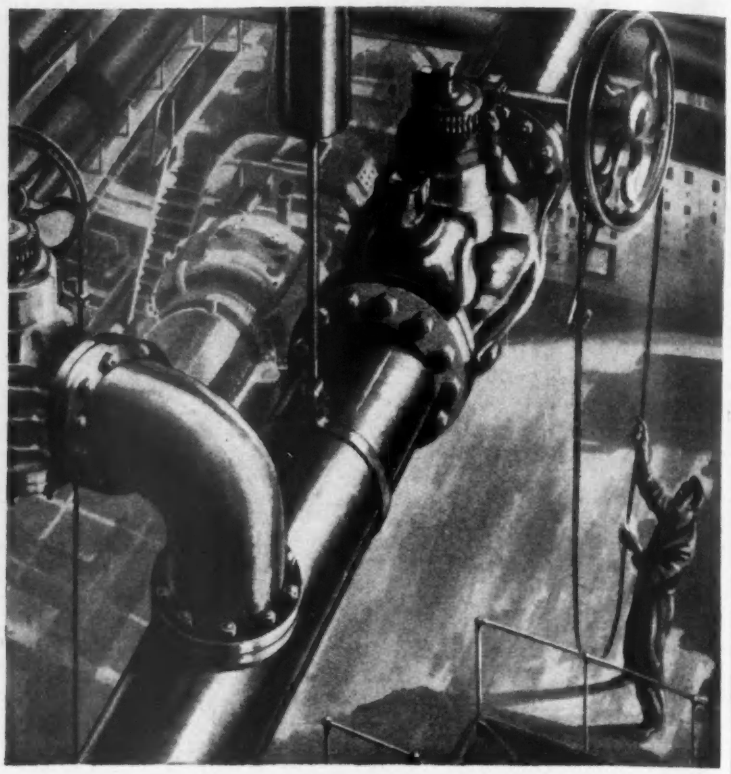
BAKERS

TAKE THE CAKE FOR CASTINGS

STEEL UP TO TWO TONS | **MEEHANITE** UP TO EIGHT TONS

The word MEEHANITE is a Registered Trade Mark

W. A. BAKER & COMPANY LTD · WESTGATE WORKS · NEWPORT · MON · NEWPORT 64845



Unchain this man

This man is chained to the heavy responsibility of efficiently operating valves by manual control, making successful plant operation entirely dependent upon his infallibility. Hand-operation, besides being prone to human error, is wasteful in terms of time and money.

Motorisation by Rotork will eliminate the problems caused by the chain method of operating inaccessible valves.

Any size or type of valve can be fitted with a Rotork actuator for push-button or automatic operation: any number of valves can be controlled simultaneously: an arrangement of valves can be sequence-interlocked to ensure foolproof operation: centralized control of widely separated valves can be arranged from one convenient point.

Our catalogue contains extensive information about valve control. May we send you a copy?

A Rotork 100AS Actuator on a 20" class 600 Newman McEvoy conduit valve.

Rotork Actuators for Valve Control

ROTORK ENGINEERING CO. LTD., of BATH, ENGLAND · Tel: 64558

HOSE—
we'll tackle anything

When a Buyer wants a special MacLellan Hose, one of the men who see that he gets it is Duff Ross, Industrial Division Sales Manager. The vigour and dash which he showed on the rugby field until recently now goes into ensuring prompt and positive answers to customers' enquiries. Duff Ross likens his sales team to a three-quarter line, running hard and straight all the time, and never missing an opening. If you are a hose buyer, give MacLellan service a try. You'll find you'll be the one who *scores*.

MacLellan are large enough to employ the most up-to-date methods and equipment; close-knit enough to give every order individual attention; adaptable enough to meet your special needs. 'Samson', 'Stalwart', 'Staunch' and 'Sturdy' are Standard grades for suction and discharge of water, sand, slurry, etc. Other grades for chemical, oil and other services. Large stocks at all depots. Lengths generally up to 60 ft. Express delivery.

MacLellan HOSE

George MacLellan & Co. Ltd.

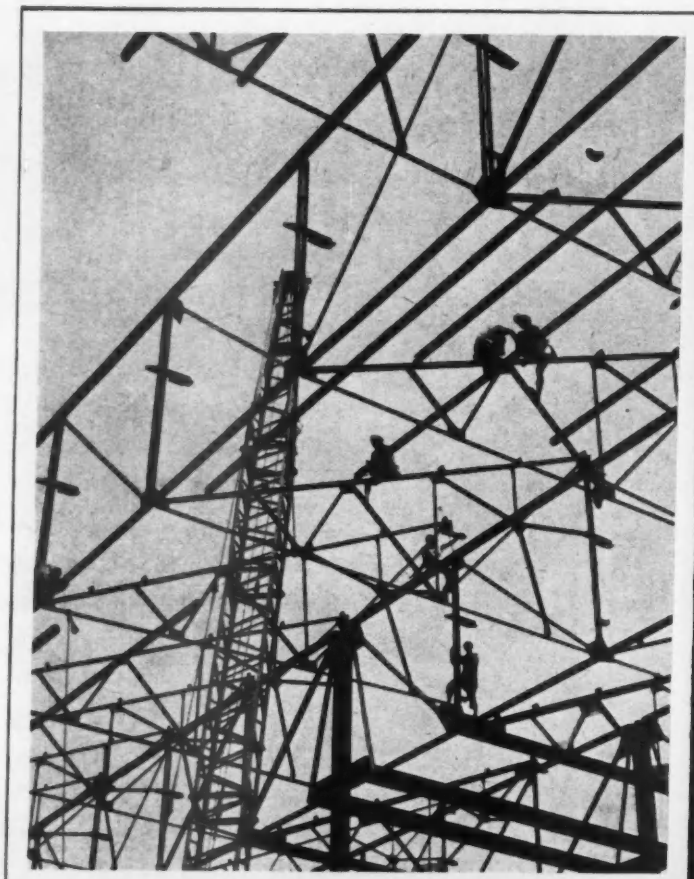
For over eighty years, makers of rubber for industry; suction and discharge hose, conveyor belting for outdoor and underground service, expansion joints, rubber jointing and cut joints, Macbond rubber and ebonite lining and covering, Mactex rubber buckets roller and idler covers, asbestos millboard, protective clothing.

George MacLellan & Co. Ltd.

185-195 SHUNA STREET, MARYHILL, GLASGOW, N.W.1
Telephone: Maryhill 5111/9 Telegrams: 'CAOUTCHOUC' Glasgow

Stocks at:
London: Burston Road, Putney, S.W.15. Telephone: Putney 5678
Belfast: 60b North Queen Street. Telephone: 22822
Newcastle: 3-5 Queen Street. Telephone: 27617

TECHNICAL REPRESENTATIVES THROUGHOUT THE COUNTRY



LOCATION—
Durgapur—India

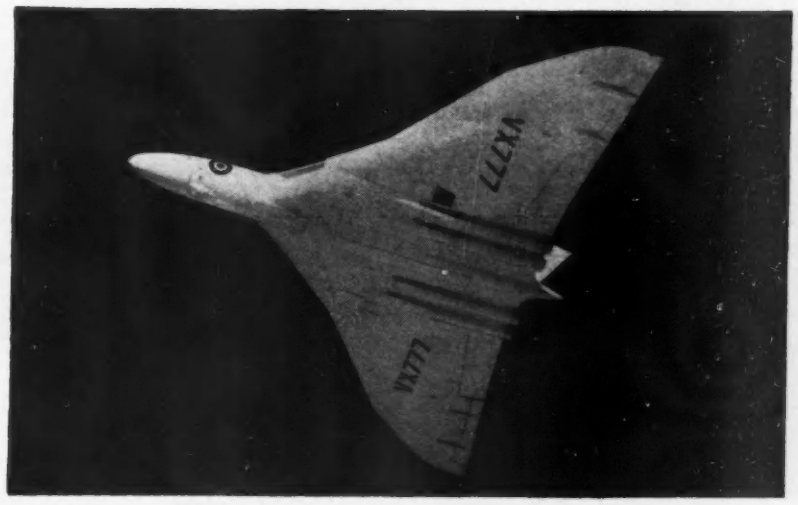
In course of erection is shown the lattice girders and roof trusses to the Light and Heavy Machine Shops and Loco Repair Shops for the Central Engineering Maintenance Department of the Durgapur Steel Project.
These form part of one of the several buildings of which the steelwork has been designed, fabricated and erected by CLEVELAND.

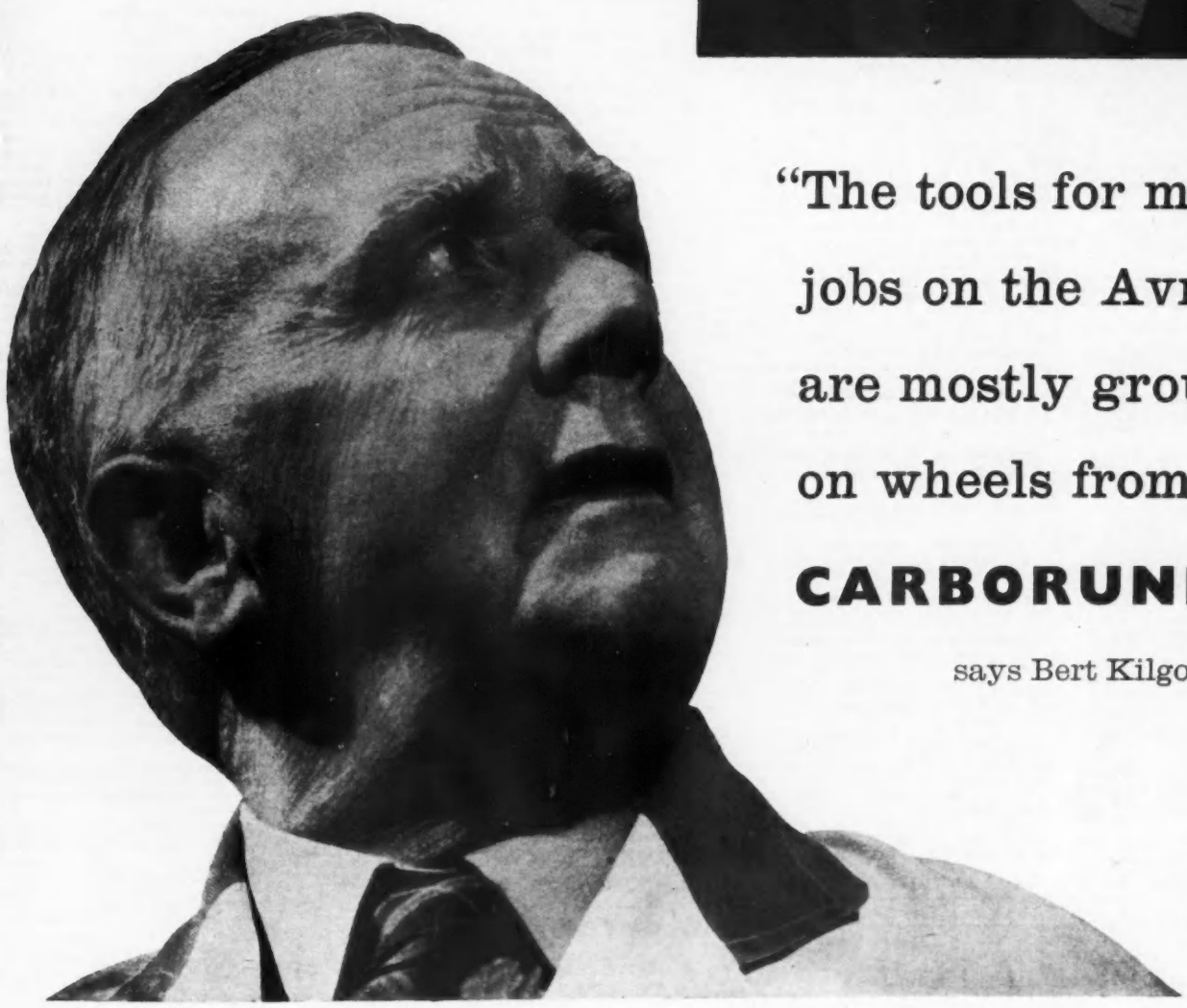
Construction by **CLEVELAND**

THE CLEVELAND BRIDGE & ENGINEERING CO. LTD. DARLINGTON, ENGLAND.

CUSTOMERS OF CARBORUNDUM

Bert Kilgour has worked at the main factory of A. V. Roe & Co. Ltd, at Chadderton, for 40 years, and is now the senior foreman of the toolroom, in which 300 men are employed: "Must be one of the biggest toolrooms in the country", Bert says. "We started getting grinding wheels from CARBORUNDUM in 1936, and they've supplied most of our wheels ever since then. That's for the whole factory—not just the toolroom. Why? Well, because their wheels do a good job, and give us good service. They've always been ready to help us when we've asked them to."





"The tools for machining jobs on the Avro Vulcan are mostly ground on wheels from CARBORUNDUM"

says Bert Kilgour

CARBORUNDUM can help YOU

In most of the major industries of the world, CARBORUNDUM is helping top firms to make better products, to cut costs, and to speed production. In the sharply competitive industrial climate of today there are three main conditions for success: high quality, low prices, and early deliveries. CARBORUNDUM can help you to meet them all.

Products by

CARBORUNDUM

TRADE MARK

can cut your costs

THE CARBORUNDUM COMPANY LIMITED · TRAFFORD PARK · MANCHESTER 17 · PHONE: TRAFFORD PARK 2381

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page. (12 column inches) and upwards, e.g. ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565

PUBLIC APPOINTMENTS

WARWICKSHIRE EDUCATION COMMITTEE

NUNEATON TECHNICAL COLLEGE AND SCHOOL OF ART

Principal: W. HOWARD JOINT, M.A.

ASSISTANTS

Applications are invited for the following new full-time posts in the Engineering Department.

(1) ASSISTANT, Grade A, for Workshop Practice in the City and Guilds of London Institute courses.

(2) ASSISTANT, Grade B, to assist in work to Higher National Certificate in Production Engineering, and to give assistance in Mechanical Craft Courses.

(3) ASSISTANT, Grade B, for Electrical craft courses and to give assistance in Ordinary National Certificate and Higher National Certificate Electrical courses.

For post (1), good practical experience in fitting shop and machine shop practice is required.

For posts (2) and (3), minimum professional requirement is Corporate Membership of an appropriate Engineering Institution.

The salary scales will be in accordance with the Burnham Technical Report and the starting points will depend upon qualifications and previous experience.

Further particulars may be obtained from the Principal, Technical College and School of Art, Hinckley Road, Nuneaton, to whom completed forms must be returned by 18th May, 1959.

N. A. Y. YORKE-LODGE,
County Education Officer.

E5812

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

DEPARTMENT OF ELECTRONIC ENGINEERING

Applications are invited for the following posts :—

(a) SENIOR LECTURER or LECTURER IN CONTROL ENGINEERING. Applicants should have research or industrial experience with servo-mechanisms or in process control.

(b) LECTURER IN MATERIALS. Applicants should have a thorough knowledge of the physics of materials and should preferably have had research or industrial experience involving solid state physics.

(c) LECTURER IN ELECTRONIC ENGINEERING. Applicants should have good qualifications in light current electrical engineering or in physics.

The salary scale for a Senior Lecturer is £1650 by £75 to £2050 per annum, and for a Lecturer is £900 by £50 to £1350 by £75 to £1650. The initial salary will depend on the qualifications and experience of the person appointed. In addition there are F.S.S.U. benefits and family allowances. The appointments will date from September 1, 1959, or from dates to be arranged with the successful candidate.

Two copies of the application should reach the undersigned, from whom further particulars may be obtained, not later than June 20, 1959.

KENNETH LAWRENCE,
Secretary and Registrar.

E5791

CIVIL SERVICE COMMISSION

H.M. DOCKYARD TECHNICAL COLLEGES

TEACHING POSTS

Teaching posts in H.M. Dockyard Technical Colleges. Pensionable (non-contributory) ASSISTANT LECTURER posts for men: three at Devonport for: (1) English with a modern language; (2) Physics, and (3) Mechanical Engineering; one each at Chatham and Rosyth for Electrical Engineering. Ability to help with other subjects essential. Appointment September, 1959, or as soon after as possible.

Qualifications: University Degree or equivalent and ability to teach special subject to H.N.C. standard. Burnham scales for Technical Colleges. Final year students may apply.

Write: Civil Service Commission, Burlington Gardens, London, W.1, for application form, quoting 4981/59. Closing date 10th June, 1959.

E5788

PUBLIC APPOINTMENTS

SURREY EDUCATION COMMITTEE

KINGSTON TECHNICAL COLLEGE

FASSETT ROAD, KINGSTON-UPON-THAMES

ASSISTANT GRADE "B"

Required for 1st September, 1959, ASSISTANT, Grade "B," for the Production Engineering and Machine Shop Engineering Courses in the DEPARTMENT OF MANAGEMENT, WORK STUDY and PRODUCTION. Candidates should hold a Higher National Diploma or Certificate in Engineering with Production Engineering subjects, or full Technological Certificate in Machine Shop Engineering or equivalent qualification, together with teaching and industrial experience. Salary: Burnham Technical Scale (men), £682 10s. by £26 5s. to £1076 5s., with additions for training, Degree and approved experience. London Allowance payable.

Further particulars and application form from the Principal, on receipt of stamped, addressed envelope, to be returned as soon as possible.

E5808

CITY OF BIRMINGHAM EDUCATION COMMITTEE

ERDINGTON TECHNICAL COLLEGE, EDWARDS ROAD, BIRMINGHAM, 24

Principal: G. GREASLEY, D.I.C., M.I.E.E., A.M.I.Mech.E.

ASSISTANT TEACHERS, GRADE "B"

Applications are invited for three posts as ASSISTANT TEACHERS, Grade "B," to commence duty on 1st September, 1959. The vacancies are in the Mechanical Engineering Department and also in the Electrical Engineering Department, both of which include classes from Pre-Senior to O.N.C. level. C.G.L.I. Intermediate courses in Machine-shop Engineering and in Electrical Installation work are also provided. Industrial and teaching experience are both desirable.

Salary Scale: £682 10s. by £26 5s. to £1076 5s. per annum. Additional increments above the minimum of the scale may be granted for industrial and commercial experience. There are also additions to the scale for a Degree or for equivalent professional qualifications.

Application forms and further details may be obtained from the Principal of the College (s.a.e.), and should be returned to him as soon as possible.

E. L. RUSSELL,
Chief Education Officer.

E5823

BEDFORDSHIRE EDUCATION COMMITTEE

MANDER COLLEGE, BEDFORD

SENIOR LECTURER

Applications invited from University Graduates with industrial and teaching experience, for appointment from 1st September as SENIOR LECTURER IN MECHANICAL ENGINEERING in the Department of Engineering, Mander College, Bedford. Specialist subjects, Strength of Materials and Theory of Machines to H.N.C. standard.

Salary scale: £1417 10s. to £1627 10s.

Forms of application and further particulars from the College Principal.

T. S. LUCKING,
Director of Education.

E5771

UNIVERSITY OF SHEFFIELD

LECTURER

Applications are invited for the post of LECTURER IN CIVIL ENGINEERING, to begin duties on 1st October, 1959. Initial salary according to qualifications and experience, on the scale £900 by £50 to £1350 by £75 to £1650, with F.S.S.U. provision and family allowance. A grant towards removal expenses will be made.

Further particulars should be obtained from the Registrar, to whom applications (4 copies) should be sent by 30th May 1959.

E5695

PUBLIC APPOINTMENTS

CITY AND COUNTY OF NEWCASTLE UPON TYNE

RUTHERFORD COLLEGE OF TECHNOLOGY

(SELECTED FOR DEVELOPMENT INTO A COLLEGE OF ADVANCED TECHNOLOGY)

APPOINTMENTS IN MECHANICAL AND CIVIL ENGINEERING DEPARTMENT

Due to expansion of the College, the Governors invite applications for the following appointments, duties to commence on 1st September, 1959 :—

MECHANICAL AND CIVIL ENGINEERING DEPARTMENT

(i) SENIOR LECTURER (2 vacancies) with experience of some of: Aerodynamics and Fluid Mechanics, Heat Transfer, Strength of Materials, Theory of Machines.

(ii) LECTURER (4 vacancies), with experience of some of: Heat Engines and Thermodynamics, Strength of Materials, Workshop Technology.

The College is housed in new and well-equipped premises with good facilities for research work and in all cases the work will be concerned with courses leading to the Diploma in Technology, Higher National Diploma or Higher National Certificate.

Candidates should possess a good Honours or Higher Degree and have had suitable industrial and/or teaching experience. Salary will be in accordance with the Burnham Technical Scale: viz., Senior Lecturer, £1417 10s. by £52 10s. to £1627 10s.; Lecturer, £1260 by £31 10s. to £1417 10s. The commencing salary is dependent upon approved previous service and experience.

Application form (returnable within 14 days) and further particulars may be obtained from the Principal, Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne, 1.

E5826

LONDON COUNTY COUNCIL

BRIXTON SCHOOL OF BUILDING

LECTURER IN CIVIL ENGINEERING

Brixton School of Building, Ferndale Road, S.W.4.

Required, September, 1959, LECTURER IN CIVIL ENGINEERING. Should be Engineering Graduate of British University and Corporate Member of an appropriate professional body; experience of Structural Engineering, and Teaching or Research experience desirable. Burnham (F.E.) Scale: £1260 by £31 10s. to £1417 10s.

Application forms from Secretary (S.A.E.), returnable by 29th May, 1959. (1047) E5816

CIVIL SERVICE COMMISSION

ARMY OPERATIONAL RESEARCH ORGANISATION

SENIOR MOTION STUDY OFFICER AND MOTION STUDY OFFICER

Army Operational Research Organisation, West Byfleet, Surrey.

(a) SENIOR MOTION STUDY OFFICER or MOTION STUDY OFFICER, Grade I (one post).

(b) MOTION STUDY OFFICER, Grade II (two posts).

Pensionable posts for men aged at least 35, 30 or 25 (according to grade) on 1st May, 1959, acquainted with standard techniques of motion and time study and having, normally, some knowledge of industrial administration and procedure (planning, costing, layout, &c.) and familiarity with technique of job analysis and evaluation. Experience in the application of these techniques in a variety of industrial technologies is essential, and sufficient engineering experience to deal with preliminary design of fixtures and devices is desirable. For post (a) knowledge of operational research techniques and ability to plan experiments are essential; and the senior post requires lecturing and teaching ability.

Salary: post (a), £1090–£1250 or £1315–£1560, according to grade; starting salary above minimum may be granted; post (b), £635 at age 25 to £795 at 30 or over, rising to £1025. Promotion prospects.

Write, Civil Service Commission, 17, North Audley Street, London, W.1, for application form quoting S4982/59. Closing date 16th June, 1959. E5817

PUBLIC APPOINTMENTS

WEST DORSET WATER BOARD

APPOINTMENTS

Appointment of:

(a) ASSISTANT ENGINEER, A.P.T. IV (£1065–£1220 per annum).

(b) ENGINEERING ASSISTANT, A.P.T. I (£610–£765 per annum).

Applications are invited for the above appointments.

Candidates for (a) must be Associate Members of the Institution of Civil Engineers and the Institution of Water Engineers, and have a thorough knowledge of Water Engineering practice, with particular reference to underground supplies, pumps and service reservoirs.

Candidates for (b) should be pursuing a course of study leading to the qualifications for appointment (a) and some intermediate examination should have been passed. General Drawing Office experience is necessary and preference will be given to candidates with some Water Engineering knowledge.

Both appointments will be subject to the provisions of the Local Government Superannuation Acts, the National Scheme of Conditions of Service and to passing a medical examination.

Forms of application and further particulars may be obtained from the undersigned and to whom applications should be returned by Monday, June 1st.

R. CHAPMAN, A.M.I.C.E., A.M.I.W.E.,
Engineer and Manager.

11, Downes Street,
Bridport,
Dorset.

E5802

SHEFFIELD CORPORATION WATERWORKS

CHIEF ASSISTANT IN-CHARGE CONSTRUCTION SECTION

Applications are invited for this post, J.N.C. Scale C (£1385–£1620), on the staff of the General Manager and Engineer, J. Noel Wood, M.I.C.E. Commencing salary according to qualifications and experience.

Applicants must be chartered civil engineers, with considerable experience of design and construction of works and preparation of contract documents. Duties include responsibility for a large programme of new works.

The appointment is subject to national conditions of service as applied by the City Council, including 3 months' notice on either side. Superannuable post; medical examination.

Alternate Saturday morning leave; car allowance. Attractive housing accommodation available to rent.

Applications, stating age, qualifications, experience, present and past appointments (with dates and salaries), and quoting the names and addresses of two referees, must reach the undersigned by 21st May, 1959.

JOHN HEYS,
Town Clerk.

Town Hall,
Sheffield, 1.

E5734

PORT OF BRISTOL AUTHORITY

CHIEF ASSISTANT ENGINEER (MECHANICAL)

Applications invited for above post. Successful applicant will be responsible to Engineer-in-Chief for maintenance of all classes of mechanical plant, including steam and diesel locomotives, road vehicles, cranes, hydraulic machinery, pumping stations, refrigeration plant, grain handling machinery and a wide variety of mechanical handling equipment; for specification and procurement of new and replacement plant; and for supervision of repair workshops employing approximately 230 men.

Applicants must hold Corporate Membership of a recognised Engineering Institution.

Salary: £1520 by £60 (3) by £55 (1) to £1755 per annum. Starting salary within this range according to qualifications and experience.

Appointment subject to medical examination and 6 months' probationary period. Post pensionable (Local Government Superannuation Act, 1953). Car allowance payable.

Applications, giving age, qualificatidns, experience, &c., to Engineer-in-Chief, Port of Bristol Authority, Avonmouth Docks, Bristol, in sealed envelope endorsed "C.A.E. (M)," by 12th June. Applicants must state whether they are related to any member or officer of Bristol Corporation. Canvassing disqualifies.

E5797

PUBLIC APPOINTMENTS

RUGBY RURAL DISTRICT COUNCIL

WIBTOFT WATER SUPPLY—CONTRACT NO. 12

WOLSTON AREA SEWERAGE AND SEWAGE PURIFICATION—CONTRACT NO. 13

APPOINTMENT OF RESIDENT ENGINEER

Applications are invited for the above appointment to supervise the following works :

CONTRACT No. 12

The construction of one 220,000 gallon reinforced concrete reservoir, including valve house, about 8 miles of asbestos cement and spun-iron water mains, 3in. to 8in., and the provision of service connections.

CONTRACT No. 13

The laying of 5½ miles of concrete and salt-glazed ware sewers, 3½ miles of asbestos cement pumping mains, three pumping stations and the construction of sewage purification works for 7000 people.

It is expected that Contract No. 12 will commence a few months before Contract No. 13 and both will be under the direction of the Consulting Engineers, Messrs. J. D. and D. M. Watson, MM.I.C.E., 67, Tufton Street, Westminster, London, S.W.1.

The salary is £1200 per annum and the appointment, subject to satisfactory service, will last approximately 2 years and will be terminable by 2 months' notice on either side.

The period of employment may be extended to cover the supervision of further works of a similar nature within the Rural District, which it is expected will form the subject of subsequent Contracts.

A car mileage allowance will be paid and the Council will be prepared to consider making housing accommodation available, if required.

Applicants, who should be Associate Members of the Institution of Civil Engineers or have comparable qualifications and must have had experience of similar work, should apply in writing to the undersigned not later than 23rd May, 1959, giving full particulars of age, qualifications and experience and the names and addresses of two persons to whom reference may be made.

Canvassing will disqualify.

H. A. WILDE,
Clerk of the Council.

Council Offices,
24, Warwick Street,
Rugby.
27th April, 1959. E5687

CENTRAL ELECTRICITY AND WATER ADMINISTRATION

KHARTOUM, SUDAN

SHIFT CHARGE ENGINEERS

SHIFT CHARGE ENGINEERS required for service in Burri Steam Power Station, Khartoum. Salary in the range of £S.1200–£S.1600 (£S.1= £1 0s. 6d.), plus cost-of-living allowance, free house with hard furnishings and free supplies of electricity and water.

Contracts will be for three years, with a bonus of 10 per cent of basic salary over the contractural period. A generous leave allowance with free passage for employee and family.

The Power Station consists of 20MW of modern steam power plant with 10MW of diesel stand-by and peak load plant.

Applications, giving age, qualifications, experience, present position and salary, together with names of two referees, should be addressed to The Power & Traction Finance Co., Ltd., Queens House, 28, Kingsway, London, W.C.2. E5787

LEICESTER WATER DEPARTMENT

MECHANICAL AND ELECTRICAL ENGINEER

MECHANICAL AND ELECTRICAL ENGINEER required by the Leicester Water Department, for work on the design, installation and maintenance of pumping and treatment plant, switchgear, remote control systems and mechanical plant.

Candidates should preferably be Chartered, Mechanical or Electrical Engineers, or at least hold the Higher National Certificate. Workshop and drawing-office experience is necessary, but previous experience with a water undertaking is not essential. Salary will be A.P.T. IV (£1065 to £1220).

The appointment is subject to the provisions of the Local Government Superannuation Acts, 1937 to 1953, and to a satisfactory medical examination.

Applications, giving full details of training and experience should be submitted before Saturday, 30th May, 1959, to the Engineer and Manager, Water Department, Bowling Green Street, Leicester. E5783

THURROCK URBAN DISTRICT COUNCIL

ENGINEER AND SURVEYOR'S DEPARTMENT

ENGINEERING ASSISTANT

Thurrock Urban District Council (Engineer and Surveyor's Department) require ENGINEERING ASSISTANT. Salary within A.P.T. I/II : £610–£880 per annum. Candidates should have completed their training in a Municipal or Civil Engineer's Office and have had some subsequent experience. Appointment pensionable.

Applications, stating age, qualifications and experience, and quoting three referees, to Clerk of the Council, Council Offices, Grays, Essex, by 26th May, 1959. Canvassing disqualifies. Relationship with Members or Senior Officers of the Council must be disclosed. E5778

PUBLIC APPOINTMENTS

GHANA PUBLIC SERVICE COMMISSION

APPOINTMENTS

Applications are invited for the following vacancies:

ASSISTANT CHIEF ENGINEER, RURAL WATER DEVELOPMENT. Normally stationed at Tamale and responsible for the administration and organisation of the department's activities in Northern Ghana. Candidates, preferably below 45, must be Graduates (B.Sc. Eng. or other recognised Engineering Degree), with not less than 12 years' approved post-qualification experience, or must have passed Parts I and II of the examination of the Institution of Civil Engineers and have obtained not less than 10 years' approved experience subsequent to passing the examination, 5 years of which should have been spent in the design and operation of water supply of various types. Preference will be given to Associate Members of the Institution of Water Engineers or of the Institution of Mechanical Engineers. Salary in range £2280–£2400, according to age, qualifications and experience.

ENGINEER, PUBLIC HEALTH, MINISTRY OF HEALTH.—To advise on the application of engineering techniques to health problems (e.g. control of malaria, schistosomiasis, guinea worm, alimentary infections) and, particularly during the designing and constructional stages, on the health aspects of all engineering projects such as roads, railways, dams, irrigation, water supply, sewages, housing and similar projects undertaken by Government or any other authority ; and undertake or direct research into techniques that may be applied in the above circumstances.

Candidates must : (a) possess a B.Sc. (Eng.) or other recognised Engineering Degree, or must have passed Part I and II of the examinations of the Institution of Civil Engineers ; and (b) must have undergone a recognised course of training in Public Health Engineering ; and (c) must have gained not less than 9 years' post-graduate experience, of which not less than five years must have been spent in the tropics as Public Health Engineer or Municipal Engineer. Salary in range £2280–£2400 per annum.

Terms of Service : Appointments will be on contract/gratuity terms for two tours each of 15–18 months. Gratuity at rate of £12 10s. for each completed month of service. Secondment or pensionable terms may be arranged. Free first-class passages for officer, wife and up to three children under 18 years and in addition an education allowance for children when not resident in Ghana of £100 a child for up to 3 children under 18 years. Accommodation at low rental. Interest-free advance for car and car maintenance allowance. Generous home leave on full pay. Income tax at low local rates.

For further particulars and application form, write, stating age, qualifications and experience, to THE DIRECTOR OF RECRUITMENT, GHANA HIGH COMMISSIONER'S OFFICE, 13, BELGRAVE SQUARE, LONDON, S.W.1. E5806

NATIONAL COAL BOARD

SOUTH WESTERN DIVISION

ENGINEERING DRAUGHTSMAN (MECHANICAL)

Invite applications for the post of ENGINEERING DRAUGHTSMAN (MECHANICAL) at their Garw Group Office in their No. 2 (Maesteg) Area.

The successful candidate will assist the Group Engineer with Engineering Drawings including reorganisation and further development of collieries.

Applicants should hold at least the O.N.C. in Engineering.

Salary range : £740–£855 per annum.

Please quote Staff Vacancy No. 66/43.

Full particulars of age, qualifications, experience and positions held, together with details of present post and salary, should be sent to the Area Staff Manager, Area No. 2, National Coal Board, Tondu, Aberkenfig, Bridgend, Glam., by 22nd May, 1959. E5760

ORMSKIRK & DISTRICT HOSPITAL MANAGEMENT COMMITTEE

ASSISTANT ENGINEER

ASSISTANT ENGINEER for Group Appointment, with duties mainly at the smaller hospitals. Successful candidate will be required to live within accessible distance from Ormskirk. Whitley Council Professional and Technical Staff conditions of service and salary, viz. £575, rising by annual increments of £25 to £700. Applicant should have served an apprenticeship in Mechanical Engineering and have a knowledge of Electrical Engineering.

Applications to be addressed to the undersigned, giving full details of age, training, previous occupations, and giving two names for reference, not later than 26th May, 1959.

H. E. BECK,
Group Secretary.

E5793

EAST ANGLIAN REGIONAL HOSPITAL BOARD

ASSISTANT ENGINEER (MECHANICAL)

Candidates should be Grad.M.I.Mech.E. and/or A.M.I.H.V.E., or equivalent, with experience in design and installation of heating, ventilating, steam boiler plant and services, &c., as applicable to hospitals. Salary : £730–£1055—additional increments within scale based on experience and age may be granted.

Applications, giving full details of age, qualifications, experience and present salary, &c., with names of three referees, to Secretary of Board, 117, Chesterton Road, Cambridge, by 1st June, 1959. E5777

PUBLIC NOTICES

EROSION OF TEETH

THE INDUSTRIAL INJURIES ADVISORY COUNCIL are considering whether erosion of the teeth due to acid fulfils the conditions for prescription under the National Insurance (Industrial Injuries) Act, 1946, as a disease for which industrial injuries benefits may be paid, and if so, in relation to what occupations. Persons and organisations interested are invited to submit written evidence which should reach the Secretary, Industrial Injuries Advisory Council, 10, John Adam Street, London, W.C.2, by the 15th September, 1959. An explanatory memorandum will be sent on request. E5774

TENDERS

ADMIRALTY

N.A.T.O. COMMON INFRASTRUCTURE SLICES VII AND VIII

P.O.L. DEPOT NO. I—PUMPING SETS

Final Notice is hereby given that BIDS will be invited in July, 1959, for the PROVISION and INSTALLATION of PUMPING EQUIPMENT at a P.O.L. Storage Depot, to be built in the Loch Striven area of Scotland.

(2) The approximate cost of the contract will be £45,000 and will include :—
(a) For duty on furnace fuel oil :—
3 (No.) Steam Turbine-driven Centrifugal Pumps about 1100 cubic metres per hour capacity each.
1 (No.) Steam-driven Reciprocating Pump about 53 cubic metres per hour capacity.
(b) For duty on white oils :—
3 (No.) Diesel Engine-driven Centrifugal Pumps about 750 cubic metres per hour capacity each.
3 (No.) Electric Motor-driven Centrifugal Pumps about 280 cubic metres per hour capacity each.
(c) For duty on ballast :—
1 (No.) Electric Motor-driven Centrifugal Pump about 80 cubic metres per hour capacity.
(d) For duty on water :—
1 (No.) Diesel Engine-driven Centrifugal Pump about 70 cubic metres per hour capacity.

(3) The work will be undertaken as one contract, and will be carried out as a sub-contract within the main contract for the construction of the depot. A final notice for the main contract has not yet been published.

(4) It should be noted that the importation of labour from sources outside the United Kingdom may be subject to restriction and that permission could in any case be granted only on an undertaking that the Contractor would pay rates of wages and observe hours and conditions of labour not less favourable than those established for United Kingdom labour for the trade or industry in the same area.

(5) Firms wishing to be invited to Bid on the basis of sub-contractor to a main contractor must formally notify their desire to Tender by application to the address given in paragraph 8 below not later than 10th June, 1959.

(6) Within one week of the closing date for receipt of applications to Bid, firms wishing to be invited must forward the following information :—
(a) Statement of financial resources and evidence of financial stability.
(b) Details of recent contracts completed for work of a comparable nature, including an indication of the value of each.

(7) Bids will be received mid-August, 1959.

(8) Enquiries regarding Bidding should be addressed to :—
Civil Engineer-in-Chief,
Admiralty,
Chamberlain Way,
Pinner,
Middlesex, England,
quoting reference C.E. in C./INFRA/9 (Sub-Contract Pumps). E5799

BOROUGH OF FARNWORTH

CONTRACT NO. 5

MAIN OUTFALL SEWER

TENDERS are invited for the CONSTRUCTION of about 550 lin. yds. of 78 inch diameter BRICK-LINED SEWER in tunnel, constructed with pre-cast concrete segments (including work under a railway), about 250 lin. yds. of 57 inch diameter to 78 inch diameter concrete pipe laid in open trench, about 100 lin. yds. of 9 inch diameter to 36 inch diameter concrete pipe sewer laid in open trench, various manholes mainly constructed with pre-cast concrete segments, a sewage diverter station, about 100 lin. yards of 4 inch diameter rising main and various ancillary works, including diversion of existing sewage flows.

The work will be carried out in the vicinity of Moses Gate Station and under Hall Lane, Farnworth.

Copies of the Tendering documents, comprising general conditions of contract, specification, bills of quantities and drawings, may be obtained from the Council's Consulting Engineers, Messrs. J. D. and D. M. Watson, MM.I.C.E., 67, Tufton Street, Westminster, London, S.W.1, after 12th May, 1959, on payment of a deposit of ten guineas refundable only to Contractors who submit bona fide Tenders and return all documents and drawings. Deposit cheques should be made payable to J. D. and D. M. Watson.

Tenders must be returned in envelopes which do not bear any name of mark indicating the sender, but endorsed "Tender for Contract No. 5, Main Outfall Sewer," and delivered at the office of the undersigned by noon on Tuesday, the 23rd June, 1959.

THOMAS HITCHEN,
Town Clerk.

Town Hall,
Farnworth,
Lancs. E5781

TENDERS

ADMIRALTY

N.A.T.O. COMMON INFRASTRUCTURE SLICES VII AND VIII

P.O.L. DEPOT NO. I—JETTY OIL FLOW-BOOM EQUIPMENT

Final Notice is hereby given that BIDS will be invited in July, 1959, for the PROVISION and INSTALLATION of JETTY OIL FLOW-BOOM EQUIPMENT at a P.O.L. Storage Depot to be built in the Loch Striven area of Scotland.

(2) The approximate cost of the contract will be £32,000 and will include :—
(a) 1 (No.) complete Oil Flow-boom Equipment for 7 (No.) 10in. hose connections.
(b) 1 (No.) Light Derrick.

(3) The work will be undertaken as one contract, and will be carried out as a sub-contract within the main contract for the construction of the depot. A final notice for the main contract has not yet been published.

(4) It should be noted that the importation of labour from sources outside the United Kingdom may be subject to restriction and that permission could in any case be granted only on an undertaking that the Contractor would pay rates of wages and observe hours and conditions of labour not less favourable than those established for United Kingdom labour for the trade or industry in the same area.

(5) Firms wishing to be invited to Bid on the basis of sub-contractor to a main contractor must formally notify their desire to Tender by application to the address given in paragraph 8 below not later than 10th June, 1959.

(6) Within one week of the closing date for receipt of applications to Bid, firms wishing to be invited must forward the following information :—
(a) Statement of financial resources and evidence of financial stability.
(b) Details of recent contracts completed for work of a comparable nature, including an indication of the value of each.

(7) Bids will be received mid-August, 1959.

(8) Enquiries regarding Bidding should be addressed to :—
Civil Engineer-in-Chief,
Admiralty,
Chamberlain Way,
Pinner,
Middlesex, England,
quoting reference C.E. in C./INFRA/9 (Sub-contract Flow-Boom Equipment). E5798

COUNTY BOROUGH OF READING

R6 CONTRACT WM12

Firm Price TENDERS are invited for the SUPPLY and ERECTION at Manor Farm Sewage Disposal Works of Two Single Lift GASHOLDERS of welded construction, each with a capacity of 20,000 cubic feet.

Particulars and specifications obtainable from and plans inspected at the offices of the Consulting Engineers, Messrs. Howard Humphreys and Sons, Victoria Station House, Victoria Street, Westminster, S.W.1, on and from Wednesday, 20th May, 1959, until Friday, 5th June, 1959, upon payment of a deposit of 5 guineas made payable to the Corporation, returnable for bona fide Tender not subsequently withdrawn.

No Tender considered unless on the official form and delivered to the undersigned in plain, sealed envelopes endorsed "Tender for Gasholders, Contract WM12," but bearing no indication of the sender, not later than Friday, 19th June, 1959.

The Council do not bind themselves to accept any Tender.

TOWN CLERK,

P.O. Box 17,
Town Hall,
Reading, Berks.
May, 1959. E5758

SCOTTISH HOME DEPARTMENT

ABINGTON-LANARK-AIRDRIE-CUMBERNAULD TRUNK ROAD A.73

CARTLAND BRIDGE, LANARK.

The Secretary of State invites TENDERS for ROAD AND BRIDGE IMPROVEMENTS at Cartland Bridge, Lanark. The Works include realignment of the immediate road approaches and the provision of a reinforced concrete deck slab and cantilevered walkway to the existing bridge structure.

Contract documents and drawings are obtainable from Messrs. Babtie, Shaw and Morton, Chartered Civil Engineers, 17, Blythswood Square, Glasgow, C.2, upon payment of a deposit of £10 by cheque made payable to the order of the Queen's and Lord Treasurer's Remembrancer. The deposit will be returned if a bona fide Tender is submitted and not subsequently withdrawn.

Tenders on the official form, which must be received before 4 p.m. on Friday, 5th June, 1959, should be sent by registered post, marked—"Cartland Bridge Tender"—to the Secretary, Scottish Home Department, Broomhouse Drive, Saughton, Edinburgh, 11.

The Secretary of State does not bind himself to accept the lowest or any Tender. E5757

Classified Advts. continued on page 120

TENDERS

NEWCASTLE AND GATESHEAD WATER COMPANY

SOUTHERN TRUNK MAIN

The Newcastle and Gateshead Water Company, acting on behalf of the proposed Coquet Water Board (a bulk supply Board which will supply water to the Company, the Tynemouth Corporation and certain County districts in Northumberland), invite TENDERS for the LAYING of 36in. nominal diameter STEEL PIPES and the FITTING and CONSTRUCTION of ANCILLARY WORKS, all in Northumberland, as follows :—

CONTRACT No. 2—from Warkworth to a point near West Shield Hill in the parish of Hebron in Morpeth R.D.C.—total length approximately 60,970 lin. ft. The Tenderer will be required to provide alternative prices for jointing 36in. nominal diameter steel pipes with welded joints and Viking Johnson couplings.

CONTRACT No. 3—from the said point near West Shield Hill to Sandy Lane in Longbenton U.D.C.—total length approximately 60,948 lin. ft., jointed with Viking Johnson couplings.

Tenderers may submit Tenders for either Contract No. 2 or Contract No. 3 separately or Contracts Nos. 2 and 3 together.

Tender documents may be obtained from the undersigned on payment of deposits of five guineas for each (making ten guineas for documents necessary for Tendering for Contracts Nos. 2 and 3 separately or together), which will be returned on receipt of bona fide Tenders not subsequently withdrawn and on return of all documents. (Cheques should be made payable to the Newcastle and Gateshead Water Company.) Tenderers should state in their request for documents whether they wish to Tender for Contract No. 2 or Contract No. 3 or for both Contracts separately or together.

Tenders endorsed "Southern Trunk Main," in sealed envelopes not bearing any name or mark identifying the sender must be delivered to Mr. F. G. Egner, Town Clerk, County Borough of Tynemouth, 14, Northumberland Square, North Shields, not later than 10.30 a.m. on 22nd June, 1959.

The Company, acting on behalf of the proposed Coquet Water Board, are not bound to accept the lowest or any Tender.

S. G. BARRETT,
General Manager and Engineer.
Newcastle and Gateshead Water Company,
Pilgrim Street,
Newcastle upon Tyne, 1. E5688

EDUCATIONAL

UNIVERSITY OF EDINBURGH

POST-GRADUATE SCHOOL OF APPLIED DYNAMICS

A Post-Graduate Course, leading to the Diploma in Applied Dynamics, will be given in the Department of Engineering from October, 1959 to June, 1960.

Lectures will be given in the following subjects : Mechanical Vibration, Gyrodynamics, Control Systems. Laboratory work in the field of applied dynamics will also be undertaken.

A limited number of grants may be awarded to suitable candidates.

Alternatively, students may attend one or more of the lecture courses on the above subjects : each course lasts a few weeks.

Further particulars and application forms for the Diploma Course and for the Short Lecture Courses may be obtained from the Faculty of Science Office, Chemistry Department, West Mains Road, Edinburgh, 9.

CHARLES H. STEWART,
E5803 E Secretary to the University.

UNIVERSITY OF MANCHESTER

A Full-time COURSE of POST-GRADUATE LECTURES on the ADVANCED THEORY OF STRUCTURES will be held in the University of Manchester between July 6th and 18th, 1959.

The Lectures are intended for Engineers, Lecturers and Research workers who wish to study and discuss recent work in the subject. The lecturers will be Professor J. A. L. Matheson and Dr. J. E. Gibson, of the University of Manchester, Dr. N. W. Murray, of the University of Sheffield, and Dr. R. K. Livesley, of Cambridge. The topics to be covered include the General Theory of Hyperstatic Structures ; Stability of Frameworks, Matrix Analysis of Structures ; the Use of Computing Machines for Frameworks and Shells.

The fee for the Lecture Course is £15.

Accommodation for those requiring it will be arranged at one of the University's Halls of Residence.

Further particulars may be obtained from the Registrar, The University of Manchester, 13. E5759 E

TECHNICAL HOME STUDY COURSES

For A.M.I.Mech.E., A.M.I.Chem.E., A.M.I.M.I., A.F.R.Ae.S., C. & G., &c.

OVER 50 FIRST PLACES and more than 2000 Passes have been secured by T.I.G.B. Students at Professional Engineering Examinations. We have a wide range of exclusive Home Study Courses in all branches of Engineering—Mechanical, Electrical, Aeronautical, Automobile, Chemical, Gas, Radio, and Television, Draughtsmanship, &c. Textbooks, blueprints, &c., are provided and, if desired, fees may be paid by moderate instalments.—Write (stating subject of interest) for copy of 110-page Prospectus FREE and without obligation.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN
(Dept. 76),
29, WRIGHT'S LANE, LONDON, W.8.
E102 E

EDUCATIONAL

AUTOMATION.—AUTHORITATIVE COURSES are now available in Digital and Analogue Computer Technology. Applied Electronics, Data Processing and Instrumentation up to professional level by home study. Individual enrolment or industrial group scheme enrolments accepted. Syllabuses and prospectus sent on request.—Write (Dept. S.E.8), E.M.I. Institute School of Electronics, College House, Kensington, London, W.8. E145 E

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London W.8. E114 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A CIVIL ENGINEERING GRADUATE is required to take charge of a fully-equipped Soil Mechanics Laboratory overseas on a two-year contract. Previous experience of all types of tests, including triaxial tests with pore water pressure measurement and dissipation tests and knowledge of maintenance of machines essential.—Apply in writing, with details of qualifications and experience, to MESSRS. BINNIE, DEACON & GOURLEY, Artillery House, Artillery Row, Westminster, London, S.W.1. E5765 A

A DESIGNER-DRAUGHTSMAN, aged between 25 and 35, for machine design connected with wire and cable producing machinery. Good machine-design experience is required but not necessarily in this field. Conditions of employment are good and the appointment will be permanent.—Write, giving full details of experience, &c., to the Secretary, BARRON & CROWTHER LIMITED, Woodside Road, Eastleigh, Hampshire. E5731 A

A SENIOR CONTRACTS ENGINEER FOR PUMP DEPT.
is required by
W. H. ALLEN SONS & CO., LTD., QUEENS ENGINEERING WORKS, BEDFORD

The appointment is a responsible one, involving the handling of projects, tenders and contracts for complete pumping schemes. Applicants should have served an apprenticeship and reached at least National Certificate standard, with experience in either drawing-office, commercial department, plant operation or manufacture.

Good Staff Pension scheme ; assistance towards removal expenses.

Apply, stating age, experience, &c., to :
THE PERSONNEL MANAGER.

E5715 A

AN ASSISTANT IS REQUIRED in the Fuel Department of a large Iron and Steel Works. The applicant should have experience in the combustion of all types of fuels, with knowledge of the use of various types of combustion control equipment. —Applications should be made, stating age, details of career and remuneration desired, to the Works Manager, GUEST KEEN IRON & STEEL CO., LTD., East Moors, Cardiff. E5728 A

APPLICATIONS ARE INVITED FOR AN ENGINEERING CHEMIST experienced in the treatment and analysis of water used as boiler feed.—Please apply, stating age, details of career and salary expected, to the Works Manager, GUEST KEEN IRON & STEEL CO., LTD., East Moors, Cardiff. E5727 A

APPRENTICE TRAINING SUPERVISOR

Applications are invited by a West of Scotland Engineering Company for the position of APPRENTICE TRAINING SUPERVISOR to have control of all aspects of Apprentice Training and Education. The position is a most responsible one and a sound scheme is already in operation Applicants must have Engineering qualifications of at least Higher National Certificate Standard and be between the ages of 30 and 45. Preference given to applicants with teaching and practical experience. Superannuation Scheme, after qualifying period.—Write, giving details of age, qualifications, past experience and reasons for considering a change of employment to 0952, Wm. Porteous and Co., Glasgow.

E5810 A

COMPETENT PERSONALITY, EX-OFFICER OR SIMILAR, AS UNDERSTUDY TO GENERAL MANAGER. Youth and inexperience of Cranes not handicaps.—Doity Cranes, Ltd., 24, Brazennose Street, Manchester, 2. E2402 A

CONSULTING ENGINEERS require SENIOR MECHANICAL ENGINEER for site supervision of Boiler and Turbine contracts at Kincardine Generating Station. Experience in erection and commissioning of modern generating plant essential. Salary commensurate with qualifications and experience.—Applications in writing to KENNEDY AND DONKIN, 4, Somerset Place, Sauchiehall Street, Glasgow, C.3. E5813 A

CONSULTING CIVIL AND STRUCTURAL ENGINEERS urgently require first class DESIGNER/DETAILERS for varied work on reinforced concrete and structural steelwork. Five-day week and luncheon vouchers.—Apply by letter or telephone to : MAURICE NACHSHEN AND PARTNERS, 58, Victoria Street, London, S.W.1. Telephone : VICtoria 0353. E5817 A

DESIGN DRAUGHTSMAN REQUIRED by old-established firm of Agricultural Engineers in Midlands, to take charge of small drawing-office. Previous experience of agricultural implements not essential. Ability to design machining and welding jigs an advantage. H.N.C. Mechanical Engineering or equivalent. Age 35–40. Non-contributory pension scheme. Assistance with house if necessary. State salary required.—BOX No. E5735, "The Engineer." A

SITUATIONS VACANT

CHEMICAL ENGINEER

A Chief Chemical Engineer is required for the central engineering division of a group of companies operating in the heavy chemical industry.

Candidates should have a Degree or equivalent in Chemical Engineering and experience in the translation of pilot plant data into large-scale practice. A good knowledge of all the usual unit operations and ability to prepare complex flow sheets is essential.

Candidates should be accustomed to calculating and assessing the economics in new processes and process methods.

The post will be located in London and will carry a good salary and membership of the Company's pension fund, and consideration will be given to financial assistance towards removal expenses and house purchase if necessary.

Candidates should reply to Box TE.654, c/o 191, Gresham House, E.C.2, giving details of previous experience, positions held and stating present position and salary. All replies will be treated in the strictest confidence.

E5786 A

DESIGN DRAUGHTSMAN required for mechanical design of nucleonic instruments. Pleasant working conditions. Excellent rates of pay.—Apply Chief Draughtsman, ISOTOPE DEVELOPMENTS, LTD., Beenham Grange, Aldermaston, Berks. Tel.: Woolhampton 451. E152 A

DESIGN ENGINEER REQUIRED having intimate knowledge of Metal Sheet and Strip Gang Slitting Machines, and associated equipment, to give full time to development and sales. First class position.—Reply : c/o DIRECTORS, THE BRONX ENGINEERING COMPANY, LTD., DUDLEY ROAD, LYE, Nr. Stourbridge, Worcs. E2406 A

DEVELOPMENT ENGINEER required by a Light Engineering Company in the Midland district. Must be experienced in design and development of small high-speed diesel and petrol engines, and it is essential that applicants should have mechanical engineering qualifications. Please write, stating details of previous experience, age and salary required.—BOX No. E5828, "The Engineer." A

DRAUGHTSMAN required in Pump Division of an old-established Engineering Company, Birmingham area. Must be experienced in the design and detailing of oil refinery, centrifugal process pumps and chemical pumps for the Oil Industry and Chemical Trades. Contributory pension scheme, five-day week, canteen and recreational facilities.—Apply, giving full details of training, qualifications, past employment and salary range, in strict confidence, to the Secretary, TANGYES LIMITED, Cornwall Works, Smethwick. E5762 A

DRAUGHTSMAN REQUIRED at L.C.C. Brixton School of Building, Ferndale Road, S.W.4, for preparation of drawings for Building and Structural Engineering Department. Should be neat draughtsman, preferably with O.N.C. 81s. 6d. to 248s., according to age and experience.—Application forms from Secretary at School. (967) E5756 A

ENGINEERING COMPANY IN IPSWICH wishes to strengthen existing drawing-office staff by appointment of two keen DRAUGHTSMEN, ages 24–28, with at least O.N.C. The office is engaged on designing a new range of medium-size machinery which requires a good knowledge of general engineering practice. Suitable applicants, who should be able to work with a minimum of supervision, are invited to send personal details and salary required.—BOX No. E5693, "The Engineer." A

ERECTION SUPERINTENDENT

Applications are invited for the above appointment by large concern engaged in the erection of Water Tube Boilers throughout U.K. Successful candidates, with proved ability, will be required to supervise and control all aspects of progress and erection. Appointment superannuable. Salary in accordance with degree of experience and qualifications.—Applications with full particulars of age, education, qualifications and experience.—Write 0650, Wm. Porteous and Co., Glasgow.

E5809 A

INSTRUMENT ENGINEER

A first class opportunity has arisen for an ENGINEER experienced in the design of electronic and/or pneumatic process control instrumentation, to join a major London Oil Refinery and Petrochemical Engineering Company.

Applicants should have at least H.N.C. with suitable endorsements.

Salary up to £1500 p.a. according to experience.

Please write giving full details in confidence to BOX No. E5811, "The Engineer."

A

ENGINEERING DRAUGHTSMAN.—THE NESTLE COMPANY LIMITED is seeking a man who wishes to assume an important post with a view to progressing to a position of authority. Those who are aged between 24 and 28, in possession of the H.N.C. and have previous experience of process or chemical layout, are invited to apply. The preparation of installation and detail drawing, together with occasional visits to our many factories within the United Kingdom, form part of the duties involved. An excellent salary and pension scheme awaits the right man, together with luncheon vouchers, whilst at our City Head Office.—Write now, giving fullest details of previous experience, age and present salary, to the Personnel Manager, The Nestlé Company, Ltd., St. George's House, Wood Street, E.C.2. E5829 A

SITUATIONS VACANT

JUNIOR DETAIL DRAUGHTSMAN required for general engineering. Applicants required who have completed full apprenticeship and Army service ready for permanent position. Write, giving full particulars.—BOX No. E2384, "The Engineer." A

LARGE MIDLAND BOILER MAKERS REQUIRE ASSISTANT CHIEF DRAUGHTSMAN, with a view to taking over duties of Chief Draughtsman during the next two years. Must have wide experience of shell boiler industry and able to negotiate at top level. Write, stating fullest details.—BOX No. E5730, "The Engineer." A

LEY'S MALLEABLE CASTINGS CO., LTD., DERBY

ASSISTANT MAINTENANCE ENGINEER required by large Foundry and Engineering Works. Some knowledge of Mechanical Handling, Hydraulic and Pneumatic Equipment, desirable. H.N.C. or similar standard preferred. Age 27–32. Interesting and progressive position. Pensions Scheme.—Applications to Works Manager, Ley's Malleable Castings Co., Ltd., Derby. E5795 A

MECHANICAL ENGINEERING DRAUGHTSMAN, preferably holding Higher National Certificate or equivalent, experienced in textile dyeing and finishing machinery.—Applications, stating age, experience, qualifications and salary required, to the Chief Engineer, THE BRADFORD DYERS ASSOCIATION LTD., 39, Well Street, Bradford, 1. E5755 A

MECHANICAL/ELECTRICAL ASSISTANT required by Quantity Surveyors London Office for Site measuring and negotiating final accounts. Reasonable knowledge all services, including air conditioning necessary. Write state age, experience in this field and salary range.—BOX No. E2409, "The Engineer." A

MECHANICAL ENGINEERS REQUIRED

Minimum H.N.C. standard, but others considered. Experience in Equipment and Pipework fabrication and erection. Should have held responsible position on oil refinery construction or similar work. Details in strictest confidence. Own staff advised.—BOX No. E5784, "The Engineer."

A

OFFICE ENGINEER

required for Iran. Period about eighteen months. "Bachelor" appointment. £150 a month plus free accommodation and messing. Age preferably not over 45.

Experience in costs and preparation of estimates for extra work and also field experience necessary. Work as Cost Engineer in field advantageous.

Selected applicants will be given fuller details at interview, meantime please state qualifications, previous employers, nature of work and age, to BOX No. E5796, "The Engineer."

A

PULSOMETER ENGINEERING GROUP

require the following staff

for work in the Clapham Area.

(a) Hydraulic Designer Draughtsman for the design and development of Hydraulic Pumps, Motors and Systems.

also

(b) Draughtsmen for layout and detailing of Hydraulic Components.

These appointments offer attractive commencing salaries and considerable scope for advancement, and are permanent and pensionable.

Candidates should write, giving full details of experience, qualifications, age, &c., to the Personnel Manager, Pulsometer Engineering Co., Ltd., Oxford Road, Reading. E5767 A

QUALIFIED STRUCTURAL ENGINEER, minimum age 28, preferably with R.C. and steel design experience to supervise section engaged on design and supervision of erection of a wide range of structures. Good prospects. Commencing salary up to £1300 p.a.—EDWARD A. PITCHER AND PARTNERS, 21a, Aylmer Parade, N.2. MOU 1852. E5822 A

R.C. DESIGNER/DETAILERS with at least 5 years' experience, required by Consulting Engineers. Able to work with minimum supervision. Salary up to £1000 p.a. according to experience and qualifications.—EDWARD A. PITCHER AND PARTNERS, 21a, Aylmer Parade, N.2. MOU 1852. E5821 A

SALES MANAGER required for established engine and gearbox manufacturers—able to organise and instil enthusiasm into department—must have technical knowledge of engines and transmissions, able to handle commercial and financial transactions. State age, education, qualifications and experience and salary required.—BOX No. E2401, "The Engineer." A

SALES MANAGER required by an East Anglian Engineering Company. Applicants should have had a thorough Commercial training with an engineering background and must be fully competent of organising sales of capital goods in competitive home and overseas markets. Apply, giving fullest possible details.—BOX No. E5692, "The Engineer." A

SENIOR DESIGNER/DRAUGHTSMAN required by REYNOLDS T.I. ALUMINIUM, LIMITED, Rheola Works, Resolven, Neath, Glam. Factory situated in very pleasant surroundings, near Swansea. Applicants must be educated to at least H.N.C. level, and prior experience of rolling mill and foundry equipment would be an advantage. Attractive salary offered to successful applicant.—Full particulars to Personnel Manager. E5780 A

SENIOR DRAUGHTSMAN required for Design Office. Work is of Electro-Mechanical nature and duties would include specification writing to Government contract requirements. Knowledge of modification procedure an advantage.—Apply, stating age and salary required, to S. G. BROWN LIMITED, Shakespeare Street, Watford, Herts. E2388 A

SITUATIONS VACANT

SENIOR PIPING ENGINEER

required by an expanding engineering contracting Company engaged on many large projects for the Oil Refinery and Petrochemical Industries.

The successful applicant will be aged 35–45, A.M.I.Mech.E., and with at least 15 years' experience in dealing with pipework problems appertaining to the above industries.

A salary in the region of £2000 p.a. is envisaged and only engineers with adequate experience and capabilities need apply.

Please write, giving full details, to General Manager.—BOX No. E5754, "The Engineer." A

STEWARTS AND LLOYDS, LIMITED
have a vacancy for a
SENIOR

in the Methods Department of their Tollcross Steel Foundry. Applicants should preferably have worked with both alloy and plain carbon steel castings, in the weight range up to 6 tons, but more important is a thorough practical knowledge of modern steel foundry methoding. —Written applications, giving full particulars of Education, Age and Experience, should be addressed to The Manager, Personnel Services, Clyde Tube Works, Coatbridge. E5709 A

STRUCTURAL DESIGNER required with experience in the design of steel structures. Opportunity for young man to become fully conversant with modern fabrication methods. Write, stating qualifications, age and salary desired to Works Director (Personal), JOSEPH WESTWOOD AND CO., LTD., Napier Yard, Millwall, E.14. E2408 A

STRUCTURAL ENGINEER, HONG KONG, thoroughly experienced in design of reinforced concrete. Salary £1700 p.a. to £2200 p.a., according to experience, plus £750 p.a. quarters allowance for 3 years' contract, plus 6 months' paid home leave with passages both ways. Applications, stating age and experience.—BOX No. E2413, "The Engineer." A

STRUCTURAL STEELWORK DESIGNER with a good knowledge of light structures as well as conventional steel design required by Consulting Engineers. Five-day week. Pension Scheme; holiday arrangements honoured.—Apply stating full details of experience and salary required to BOX No. E2407, "The Engineer." A

TECHNICAL ASSISTANTS REQUIRED for interesting design work in Midlands. Age 25 to 35. Minimum qualifications, H.N.C. Salary £800/£1000 per annum. Apply.—BOX No. E2400, "The Engineer." A

TECHNICAL REPRESENTATIVE, resident West London, required to handle power transmission equipment in Southern England. Minimum technical qualification H.N.C. Car provided. Full details, age, experience and salary required.—BOX No. E5827, "The Engineer." A

TECHNICAL ESTIMATOR required in Pump Division of an old-established Engineering Company, Birmingham area. Experience in tendering for centrifugal refinery process pumps and chemical pumps for the Oil Industry and Chemical Trades essential. Contributory pension scheme, five-day week, canteen and recreational facilities.—Apply, giving full details of training, qualifications, past employment and salary range, in strict confidence, to the Secretary, TANGYES LIMITED, Cornwall Works, Smethwick. E5761 A

THE FORESTAL LAND, TIMBER AND RAILWAYS COMPANY, LTD., requires a PROJECT ENGINEER for its works at Widnes. The Company has embarked on a programme of diversification which will provide the challenge, stimulus and opportunity associated with an expanding organisation. Applications are invited from men aged 35 or less having appropriate experience in the chemical and/or food industries, including control of the drawing office, preparation of detailed specifications and negotiations with suppliers. They should have a degree in mechanical engineering, or corporate membership of the Institution of Mechanical Engineers, and a good background of experience in the various stages of a project from flow sheet to commissioning should be coupled with the ability to grasp quickly and concisely the essentials of specific problems. The Company offers first-class service conditions and applications, which will be treated in confidence, should be addressed to the Development Manager, The Forestal Land, Timber and Railways Company, Ltd., Ditton, Widnes, Lancs. E5800 A

TRANSLATOR wanted for Switzerland. German, French into English only. Interesting, permanent post for versatile, experienced man with all-round technical background. Polished English style essential. Reply.—BOX No. E2392, "The Engineer." A

VACANCY FOR MAN FOR GENERAL TRACTOR REPAIRS, &c., and to run Cold Storage Plant. Modern house on Farm.—Apply: THE GROVE FARMS (HARWELL) LTD., Woodlands, Milton Hill, Nr. Abingdon, Berks. E5742 A

VESSEL ENGINEER

required by International Oil Refinery Engineers. Must be A.M.I.Mech.E. standard, with design and workshop experience covering large columns, pressure vessels, tanks and Heat Exchangers and familiar with British and American specifications and codes for the Oil Refinery and Petrochemical Industries.

Salary up to £1750 p.a., according to experience.

Please write, giving full details.—BOX No. E5753, "The Engineer." A

WHESSOE LIMITED
Darlington,
require a
DESIGNER

with H.N.C. or Degree and D.O. and workshop experience. The job calls for experience of structural work and of designing chemical plant using pressure vessel codes; it offers plenty of scope for originality and inventiveness.

Apply in detail to THE STAFF OFFICER, Whessoe Limited, Darlington, quoting this paper and the reference 11/59.

E5773 A

WORK STUDY OFFICER

LAPORTE CHEMICALS, LTD., a member of the Laporte Group of Companies, invite applications for the post of WORK STUDY OFFICER at their works in Warrington.

Applicants should have had experience of method and time study techniques and cost control. The work involved will be on chemical processes and engineering maintenance. Age between 30–45 years. The salary offered will be commensurate with age, qualifications and experience. There is a pension scheme. The successful applicant may also qualify for assistance towards removal expenses and house purchase.

Replies, giving details of age, qualifications and experience and quoting Ref. LCW/TE1/43 should be addressed to Laporte Group Personnel Manager, Hanover House, 14, Hanover Square, W.1.

E5814 A

WORLD-WIDE SHOE MANUFACTURING AND DISTRIBUTING ORGANISATION require a GRADUATE ENGINEER aged 24–25 years, with at least one year's experience in engineering, preferably with die and tool making.

Applicants, who should be willing to work abroad if required, should have French as their second language.

The applicant selected could expect, after a short probationary period, to be given responsibility for a section of a rapidly expanding engineering production workshop in Brussels.

This position, which is pensionable and carries life insurance, is a responsible one, and a good salary will be paid to the right man.

Apply in the first instance in writing to:
The Personnel Manager,
Bata Development, Limited,
151, Oxford Street,
London, W.1. E5805 A

WATER-TUBE BOILER PLANT DESIGN

STAFF VACANCIES

(*a*) Senior and Junior Design Engineers for Proposal and Contract work on Water-Tube Boiler Plant. Previous experience on Water-Tube Boiler design preferable but not absolutely essential. Minimum qualifications are an engineering degree and/or A.M.I.Mech.E., while starting salary will be in the range £650 to £1150 p.a., dependent upon qualifications and experience. The work is interesting and varied and covers a wide field of heat-transfer applications.

(*b*) Proposal Draughtsman for interesting work on complete Water-Tube Boiler installations. Applicants should have some previous experience on Water-Tube Boiler Construction and layout. Salary according to experience but not less than £15 per week.

Five-day week, Pension Scheme. Staff Dining Room.

Write, Staff Manager,
FOSTER WHEELER, LTD.,
3, Ixworth Place,
London, S.W.3. E5782 A

MOUNT ISA MINES LIMITED, QUEENSLAND, AUSTRALIA

Vacancies for

JUNIOR MECHANICAL ENGINEERS
(Single Men)

Qualifications: B.Sc. in Mechanical Engineering.

Duties: Technical Assistant to Senior Engineers.

Salary: £A1300 per annum for new University Graduates. £A1360 for graduates with one year's experience. In addition to salary, successful applicants will receive variable Lead Bonus with a Minimum of £A5 per week and a Maximum of £A17 5s. per week.

Applications: Stating age and details of qualifications and experience to:—

London Secretary,
Mount Isa Mines Limited,
Adelaide House,
King William Street, London, E.C.4

E5776 A

UNITED STATES POSITIONS
for
SCIENTISTS and ENGINEERS

The **WESTINGHOUSE ELECTRIC CORPORATION** has a large number of openings for

PHYSICAL SCIENTISTS
and
ELECTRICAL ENGINEERS

to work in the Solid State Device field.

Positions are available at laboratories in the vicinities of Pittsburgh and Baltimore.

The programme includes fundamental studies of crystal growth phenomena, investigations of the fundamentals of device fabrication techniques, studies of binary and ternary compound, creating and developing new solid state devices and complete electronics system design.

These positions demand Ph.D. or equivalent personnel.

Starting Salary: £3400 per annum and upwards plus transportation to location.

Doctor Clarence Zener, Director of the Westinghouse Electric Research Laboratories, with other Westinghouse scientists, will interview applicants in London from Thursday, 21st May, onwards.

Selected applicants not attending the London International Convention on Transistors and Associated Semi-Conductor Devices will be invited to London for interview.

Those interested should send professional qualifications to Mr. H. R. Arnold, Westinghouse Electric International Company, 1–3, Regent Street, London, S.W.1.

E5749 A

POWER RECTIFIER DESIGN

(*a*) ENGINEERS. Due to expanding business, a large electrical manufacturing firm in the Midlands requires Assistant Design Engineers for rectifier work. Previous rectifier experience not essential, but applicants should have degree (electrical) or equivalent, and some practical training. Work involves mercury arc and semi-conductor rectifiers and application engineering of all kinds, with scope for wide experience and interest; good salary and prospects. Pleasant residential area, ample housing, excellent educational facilities.

(*b*) DRAUGHTSMEN also required for same business. Must have previous experience electrical apparatus.

Apply, with full particulars, to BOX No. E5689, "The Engineer."

A

BOOKS and PUBLICATIONS

Electronic Engineering

A monthly journal for the professional electronics engineer.

It circulates to 86 different industries all over the world.

When electronic engineering is studied "Electronic Engineering" is read.

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Price 3/- per copy.
36/- per Annum.

28 ESSEX STREET, STRAND, W.C.2

Telephone: Central 6565

Published by Morgan Bros. (Publishers) Ltd.

Classified Advts. continued on page 122

SITUATIONS VACANT

SALES REPRESENTATIVES

A very old-established firm of Engineers and Gear Specialists requires SALES REPRESENTATIVES having an established connection amongst Buyers of Medium and Medium/Heavy Plant, e.g. Steelworks, Shipyards, Mines, &c. Applicants, who should have some technical knowledge, are asked to submit full details, stating experience, area covered and salary expected. The firm's own staff have been informed of this advertisement.—BOX No. E5819, "The Engineer."

A

SITUATIONS VACANT

ELECTRICAL ENGINEER

wanted by leading German manufacturer for German-English translations. Applications are invited from British-trained engineers with a good general education and sound technical training, preferably also with practical experience in the application of electric equipment. Good working knowledge of German is essential. The ability to write clearly and concisely will be expected of candidates. A five-day week is worked, with generous holidays. Favourable housing conditions for permanent staff. Apply, stating age, education, qualifications, experience and salary required, to BOX No. E5790, "The Engineer."

A

SITUATIONS VACANT

SHELL

THE SHELL GROUP OF COMPANIES
require

ENGINEERS

for service primarily overseas in their marketing organisation. Initial duties comprise planning, construction, maintenance and operation of bulk petroleum storage plants and other distribution facilities. The variety of jobs performed in the early stages of such a career provides administrative training and experience so that those starting along this route have equal opportunities with others to compete for the highest posts in management.

Candidates should be qualified Engineers and aged between 24 and 28 years and preference will be given to men either with a University Degree in Engineering or who are Graduates of a major Engineering Institution (Mechanical Civil or Electrical).

Please write, giving full details, to:
SHELL INTERNATIONAL PETROLEUM COMPANY LIMITED,
PERSONNEL (RECRUITMENT)/M.E.,
ST. HELEN'S COURT,
GREAT ST. HELEN'S,
LONDON, E.C.3.

E5801 A

SITUATIONS VACANT

ENGINEERS

The development of engineering associated with Hospital Building has reached an extremely interesting stage. Engineers who are interested in working with progressive architects undertaking Hospital Building as Principal Assistant, £1235 to £1510 p.a., should apply for further particulars to :

The Secretary, Oxford Regional Hospital Board, 43, Banbury Road, Oxford.

The closing date for applications for the post is 30th May, 1959.

E5804 A

BRITISH OXYGEN COMPANY LIMITED

have a vacancy for a

CHIEF DESIGN ENGINEER

for one of its subsidiary companies in the London area. This light engineering manufacturing company markets its products through retail channels all over the world and direct to industry. Responsibility will be to the Development Director for the leadership of a team of engineers working on the design of new products and the application of new processes. There will be ample scope and every encouragement for new ideas and original thinking.

A good honours degree in mechanical engineering is desirable, and a further degree would be an advantage, but a physicist with suitable experience would be considered. Age preferably 33–40.

Commencing salary in region of £2000 with good prospects. Contributory pension scheme. Assistance with removal expenses if necessary.

Reply, with full details of qualifications and experience in strict confidence to :

The Staff Officer,
BRITISH OXYGEN COMPANY LIMITED.
Bridgewater House, Cleveland Row,
St. James's, London, S.W.1.

E5807 A

ASSISTANT MANAGING DIRECTOR

UNIVERSITY GRADUATE preferably in engineering, aged 30 to 38, with experience of production and supervision, required by a substantial manufacturing company.

High commencing salary in accordance with ability and experience, with prospects of £4000 p.a. within a few years.

Please apply stating age, present salary, training and positions held in chronological order to BOX No. E 5815, "The Engineer."

A

CENTRAL ELECTRICITY GENERATING BOARD

SECOND ASSISTANT ENGINEER (MECHANICAL) Ref. ENR/164

required in the Leeds Regional Office of the Production, Inspection and Test Section of the Design and Construction Department.

The Section is concerned with the production, inspection and test in Manufacturers' works of plant and equipment required for generation (including nuclear) and transmission purposes.

Candidates should have qualifications at least equivalent to Graduate Membership of the Institution of Mechanical Engineers and have had recent experience of production, inspection and test of mechanical plant in Manufacturers' works.

Salary within scale £1,195–£1,545 p.a.

CIVIL ENGINEERING DRAUGHTSMEN Ref. ENR/168

required at Bankside House, Sumner Street, S.E.1.

Commencing salary according to experience, within the range £660–£780 p.a.

Permanent pensionable appointments, Staff Restaurant, Sports and Social Club.

Application Forms obtainable from The Personnel Officer, Central Electricity Generating Board, 24/30, Holborn, London, E.C.1, should be completed and returned by May 29th.

Please mark envelopes "Confidential," quoting relevant reference number.

E5794 A

VICKERS-ARMSTRONGS (ENGINEERS) LIMITED, BARROW-IN-FURNESS

are seeking first-class men for the following vacancies :—

SENIOR & JUNIOR DRAUGHTSMEN

required for interesting work on pipe systems, &c., for nuclear submarines. Minimum technical qualification—Ordinary National Certificate or equivalent. Applicants should have served a recognised engineering apprenticeship.

Salary will be appropriate to experience and responsibility and there is a contributory Pension Fund.

The town is pleasantly situated on the coast adjacent to the Lake District. The Company has a well-appointed Sports Club and Grounds, with comprehensive recreational facilities, both social and sporting. An illustrated guide to the town and surroundings can be sent on request.

All applications should be addressed to the :—
Engineering Technical Manager,
VICKERS-ARMSTRONGS (ENGINEERS) LTD.,
Naval Construction Works, Barrow-in-Furness, Lancashire.

E5768 A

CIBA (A.R.L.) LIMITED

require

A SENIOR SALES ENGINEER

in their Bonded Structures Division. The work involves responsibility for sales of adhesives for metal bonding and of aluminium honeycomb. Considerable travel will be necessary in both the U.K. and abroad but the post will be based near Cambridge.

Applicants (preferably aged between 28 and 38) should :—
(*a*) Have a Degree or H.N.C. in Engineering.
(*b*) Have a good engineering background (preferably in aircraft industry).
(*c*) Have at least five years' selling experience (including selling within the aircraft industry) and
(*d*) Wish to continue in active sales work and to develop application of advanced structural techniques in a variety of industries.

The vacancy provides excellent opportunities in an expanding company working in a field of growing importance. The salary will be discussed at an interview and will depend on age, ability and experience.

Those interested should write in confidence to the Secretary, CIBA (A.R.L.) LIMITED, Duxford, Cambridge.

E5779 A

SITUATIONS VACANT

TECHNICAL MANAGER

A progressive Company specialising in Dredgebuilding, medium-sized Shipbuilding and Marine Engineering, invites applications for the post of Technical Manager.

The position calls for technical qualifications and leadership of a first-class order and will command considerable scope within the Company.

Applicants must have had a basic training in marine engineering and should preferably be around the age of 35/45. The qualifications required are an Honours Degree in Engineering, or an Ordinary Degree with M.O.T. Seagoing Certificate, or the equivalent in practice generally.

It is essential that applicants should have thorough experience in the Design and Workshop Practice of Marine and Heavy Mechanical Engineering and should have had experience in controlling both Design and Production Drawing Offices.

To the right man the post will carry a good salary, depending on qualifications and experience, with an excellent Pension Scheme and undoubted prospects for further advancement.

Write in confidence with full particulars to BOX No. E5682, "The Engineer." A

SITUATIONS VACANT

JOHNSON, MATTHEY & CO., LIMITED,

DESIGN ENGINEER

Aged 23/33, with good drawing-office experience, is required for a Chief Mechanical Engineer's office in Central London. A sound practical training and knowledge of engineering services is essential.

The work entails handling projects from the drawing-board through to construction and running in for production.

Conditions of service include free lunches and an annual bonus, also a contributory pension scheme. Salary according to age, qualifications and experience.

Write, giving full details of age, qualifications, experience, &c., to the Secretary, Johnson, Matthey & Co., Limited, 78, Hatton Garden, London, E.C.1.

E5738 A

SITUATIONS VACANT

THE BAHRAIN PETROLEUM COMPANY LIMITED

VACANCIES FOR

CHEMICAL AND MECHANICAL DESIGN ENGINEERS

Applicants for these positions in Bahrain should have a Degree in CHEMICAL or MECHANICAL ENGINEERING, with a minimum of four years' subsequent experience covering design problems associated with liquid and gas pumping equipment, gas engines, steam turbines, heat exchangers, coolers, steam generators and boilers, piping systems, high and low pressure process units, together with the necessary calculations of flows, pressure drops, heat transfer factors and the like.

The commencing salary would depend on qualifications and experience, with a minimum of £1600 : 0 : 0 per annum, in addition to which free air-conditioned accommodation and a living allowance are provided. An initial kit allowance, medical attention, paid home and local leaves are also provided, with passage paid for the former and generous assistance towards fare for latter.

Apply in writing, with full particulars, to Caltex Services Limited, Caltex House, Knightsbridge Green, London, S.W.1, quoting "ENG." E5772 A

ENGINEERS

required at

ALDERMASTON

ENGINEER MAIN GRADE Ref. 2251/25.
ENGINEER BASIC GRADE Ref. 2256/25.

For the maintenance and operation of all types of factory services, the planning and estimating of mechanical and electrical engineering works and services and modifications to plant and equipment in Laboratories and workshops.

The duties of the main grade include responsibility to a Senior Engineer for the supervision of the above work. In addition, close liaison will also have to be maintained with Scientists in the advice and co-ordination of design, manufacture, modification, maintenance and assistance in programmes of tests with vibration machines and other similar and associated equipment.

Wide experience of this work is essential. For the main grade engineer some training and experience in the strength of materials for structural steel work would be an advantage. For the basic grade post a mechanical engineer with some electrical knowledge would probably be suitable.

QUALIFICATIONS.—A recognised engineering apprenticeship is required and Corporate Membership of a Senior Engineering Institution. Consideration for the basic grade post will be given to applicants with Graduate Membership.

SALARY : MAIN GRADE £1345–£1800.
BASIC GRADE £845 (at age 25)–£1150 (at age 34 or over)–£1315.

Contributory Superannuation Scheme. A house or substantial assistance with house purchase will become available for married officers living beyond daily travelling distance.

POSTCARDS for application forms to the Senior Recruitment Officer at the Atomic Weapons Research Establishment, Aldermaston, Berks. Please quote appropriate reference number. E5766 A

AN ASSISTANT

to the

WORKS MAINTENANCE ENGINEER

is required by

ENGLISH ELECTRIC RUGBY

His duties will include the complete maintenance of all ranges of machine tools and other works services.

Candidates for this responsible post should have served an apprenticeship with a machine tool manufacturer, hold an H.N.C., and be about 30 years of age. For the right man there is an excellent opportunity for promotion.

Please write, giving full details of experience and qualifications, to Dept. C.P.S., Marconi House, 336/7, Strand, London, W.C.2, quoting reference E1190C.

E5763 A

UNILEVER

have vacancies for

INSTRUMENT ENGINEERS

Applicants should have adequate academic or professional qualifications in electrical engineering or physics and should have design experience in electronics, process control or instrumentation.

INSTRUMENT TECHNICIANS

Applicants should have experience in the commissioning and servicing of instruments and process control equipment.

Applications giving details of training, qualifications and experience should be addressed to Head Office Staff Department (WF 40), Unilever House, Blackfriars, London, E.C.4.

E5789 A

T. & H. SMITH LIMITED,

WHEATFIELD ROAD,
EDINBURGH 11.

(Manufacturers of fine chemicals and pharmaceuticals)

Require WORKS ENGINEER to be responsible to Works Manager for the operation of all works services and for general maintenance throughout the works. He will be expected to participate in team work on development projects with other technical staff. Pension scheme in operation ; 5-day week. Salary according to qualifications and experience.—Applicants, preferably aged 30–40 years, should write to the Secretary giving full details of education, training and experience, and marking their letter "PRIVATE."

E2403 A

SITUATIONS WANTED

CHARTERED MECHANICAL ENGINEER, 34, fully experienced in all aspects of works engineering and planned maintenance. Possessing drive and organising ability seeks position as WORKS ENGINEER in light/medium engineering factory. —Apply BOX No. E2411, "The Engineer." B

ENGINEER/DRAUGHTSMAN, with small workshop and office situated in Yorkshire, open to accept Service Agencies, &c., or other proposals. All letters answered.—BOX No. E2375, "The Engineer." B

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

BUSINESS OPPORTUNITIES

BELGIAN METALLURGIC FACTORY of middle importance wants to enter into connection with British firms desirous to collaborate or to take an interest in manufacturing material in European Common Market. Write to Journal.—BOX No. E5750, "The Engineer." O

THE REPRESENTATIVE of a progressive New Zealand Engineering Company with full and extensive range of manufacturing facilities, will be visiting this country between May and August. He is keen to discuss with British and Continental manufacturers arrangements for making their products in New Zealand under licence or on a royalty basis.—BOX No. E2398, "The Engineer." O

FIRE-FIGHTING COMPANY in Airport Installation field seeks Association with Engineers having efficient Sales Organisation and desiring to extend sphere of operation and production.—Write BOX TE.655, c/o 191, Gresham House, E.C.2. E5785 O

PRACTICAL TECHNICIAN, shortly opening in Fibreglass business, seeks additional ideas for simple production runs. Mutual agreement on terms. —PEACH, 42, John Street, Luton. E2404 O

WANTED—Light Repetitive Work. Full particulars : Charlwood Engineering Company, 87, Charlwood Street, Victoria, S.W.1. E2410 O

FOR HIRE

LATTICE STEEL. Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. ('Phone, SLOane 5259). E103 E

FOR SALE

600

ECONOMIC BOILERS

Two DANIEL ADAMSON horiz. double-pass, 10ft. 6in. dia, by 16ft. by 20ft. 8in., excluding smokebox. Evap. 14,400 lb./hr., 160 p.s.i. With feed pumps, chimney, grit arrestors, induced draught fans. Ideal for oil-firing.

GEORGE COHEN,

SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
(Shepherds Bush 2070)
STANNINGLEY, Nr. LEEDS.
(Pudsey 2241). E200 O

Classified Advts. continued on page 124

FOR SALE

FRED WATKINS (ENGINEERING), LTD.

STEAM BOILERS.—Cochrane Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100/150 lb. w.p.; reconditioned 8ft. 6in. down to 3ft. dia.; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstube, all sizes.

AIR COMPRESSORS.—Two Belliss & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised; and several others of various makes and capacities.

200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 ib. pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.

MOBILE ROAD CRANES.—10-ton Lorain lorry mounted, 30ft.–70ft. extendible jib; 10-ton 33 R.B. track mounted, 40ft. jib; 8½-ton Ransomes Diesel/Electric, 21ft. jib; 6-ton Coles Diesel/Electric, pneumatics, new 1948 (2); 6-ton Coles Diesel/Electric, solids; 4-ton Coles Diesel/Electric, solids, 1945; 4-ton Jones KL44, diesel, 1950; 3-ton Jones "Super 40" diesel, pneumatics (3).

OVERHEAD CRANES.—40-ton Babcock, 40ft. span, 400/3/50, "Goliath"; 30/5-ton Adamson, 42ft. 3in. span, 400/3/50; 20/6-ton Vaughan, 42ft. 3in. span, cab type (6); 20-ton King, 42ft. 3in. span, 400/3/50; 15-ton Morris, 35ft. span, hand operated; 10-ton Morris, 45ft. span, 36ft. lift; 10-ton Morris "Goliath," 40ft. span, 400/3/50; 10-ton Vaughan, 23ft. 6in. span, 400/3/50; 10-ton Vaughan, 21ft. span, 44ft. lift; 7½-ton Wharton, 25ft. span, 400/3/50; 5-ton Henderson, 24ft. 7in. span, 1946; 5-ton Morris, 58ft. span, hand operated; 5-ton Royce, 2-motor crab, 440/3/50; 5-ton King, 29ft. 3in. span, power hoist, hand travel; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel; 4-ton Morris, 19ft. span, 220V., d.c. (3); 3-ton Adamson, 48ft. span, 400/3/50; 2-ton Adamson, 34ft. span, 400/3/50 (2); 2-ton Morris, 18ft. span; 2-ton Vaughan, 27ft. 6in span, 2-motor; majority of the above are unused.

DERRICK CRANES.—7-ton Rushworth hand, 30ft. jib; 5-ton Wilson Electric, 70ft. jib; 1½-ton Anderson Grice, hand, 40ft. jib.

RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jib; 10-ton Coles steam, 40ft. jib; 10-ton Grafton, 34ft. jib, diesel conversion; 8-ton Wilson steam, 35ft. jib; 5-ton Grafton, 35ft. jib, diesel conversion; 5-ton Smith, 50ft. jib (2); 5-ton Cowans Sheldon, 50ft. jib.

LOCOS.—Fowler diesel, 150 h.p. (2); Ruston diesel, 80/88 h.p., new 1942; Bagnall 14in. by 22in., two oil fired, one coal; Peckett steam, 7in. by 12in., 1941; also 3 miles track, 24in. gauge, Bogies, Turnouts, &c.

STEEL PIPING.—50,000ft., 2in. Galvanised, new; 60,000ft., 3in. black, new; 5000ft., 8in. seamless; 1000ft., 12in. seamless; 500ft., 14in. seamless; 400ft., 18in. riveted; 280ft., 21in. o.d. welded flanged; 3800ft., 21in. seamless flanged; 500ft., 24in. riveted; 1450ft., 27in. o.d. welded flanged; 216ft., 48in. riveted; 216ft., 60in. riveted.

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SLING ENGINEERING WORKS
COLEFORD, GLOS.
'Phone: Coleford 2271/2. E106 G

FOR SALE

FRORIEP 54in. Heavy Duty Vertical TURNING AND BORING MILLS, fitted with side head, main motor 50 h.p. New 1952. In first-class condition.

F. J. EDWARDS LTD.,
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EUSton 4681 and 3771.

E5775 G

SAMUEL PLATT MOTORISED DRAW BENCH for sale. Approximately 20ft. draw. Chain links 7½in. by 2in. by ¾in. thick. Solid spacer 1¼in. thick. Diameter of chain pins ¾in. Electrical equipment suitable for 400/3/50. Worm gear reduction unit. Weight about 5 tons.—F. J. Edwards Limited, 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham, 3. E5824 G

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NEALS "NM" 2-ton MOBILE, 35ft. jib, Ruston engine, pneumatics. £1450.

COLES 2½-ton EMA MOBILE, 16ft. jib, Perkins engine, pneumatics. £1050.

ANDERSON GRICE 3-ton Electric DERRICK, 120ft. jib, S.L.I. £1500.

JONES KL44 4-ton MOBILE, 40ft. jib, Ruston diesel, pneumatics, 1954. £2550.

ANDERSON GRICE 5-ton Electric DERRICK, 120ft. jib. New 1946. £2600.

COLES THORNEYCROFT 5-ton LORRY MOUNTED, Mk. 7, Series 7, 30ft. jib, rope derricking. £2500.

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COLES 6-ton MOBILE, 21/30ft. jibs, Perkins engine, pneumatics. £3300.

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2000-ton Down-stroke FORGING PRESS, 5ft. stroke; bed 8ft. 6in. by 8ft.; daylight 11ft.

1000-ton Down-stroke FORGING PRESS by Wellman, bed 7ft. by 6ft.; daylight 9ft.

475-ton FLANGING PRESS by Hugh Smith, table 10ft. dia., 4 vice rams.

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Replant Works,
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E5700 G

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For Sale.—Mundt type standard gauge turntable, 65ft. long, carrying capacity 150 tons approx.

WATER CRANE
3000 gallon water crane.

TURNOUTS
Twenty 1 in 8 turnouts in 75 lb. F.B. rail; interchangeable to suit L.H. or R.H.

All these items are in excellent condition.

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SELF-CONTAINED ECONOMIC BOILER, by Paxman, for sale, evap. 7000 lb./hr. at 100 p.s.i., complete with feed pump, magnetic level switch, feed water tank, &c., retubed 1957. Price £1750.—Warwick Engineers, Barrow-in-Furness, Lancashire. E2405 G

CALCIUM SILICIDE.—Finely ground CALCIUM SILICIDE—for nodular iron, exothermic compositions, etc. (now being successfully used by several foundries) at prices which save you money.—TOXANE, LTD., 47, High Street, Edgware, Middlesex. EDGware 6666. E2412 G

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QUICKWORK No. 321 Motorised Rotary Shearing Machine, with circle cutting attachment, arranged motor drive for 400/440/3/50, capacity 14 S.W.G. mild steel, depth of shear throat 30in., cuts circles from 6in. to 60in. dia., weight approximately 18 cwt.

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BLISS No. 1 Double Sided, Double Action, Geared Toggle Drawing Press, arranged for belt drive, punch stroke 7in., blankholder stroke 4½in., between uprights 17in., size of bed 16in. by 18½in., hole in bed 6½in. diameter.

CRAIG & DONALD Model 400/10, All-Steel Motorised Double Geared Press Brake of steel plate construction, arranged motor drive for 440/3/50, pressure exerted approximately 400 tons, former capacity 10ft. by ½in., width between side frames 82in., stroke approximately 4in.

BESCO High Duty Double Geared Guillotine Shearing Machine, Overcrank type, Model R, capacity 120in. by ¼in. mild steel, treadle-operated clutch, motorised for 400/440/3/50.

New BESCO 8ft. 4in. by ⅛in. Type HK., All-Steel Undercrank Open Ended Production Power Guillotine of all-steel construction, arranged motor drive for 400/440/3/50, length of blades 110½in., capacity ⅛in., gap in side frames 3½in., strokes per minute 54.

INCANDESCENT Forced Draft Bar Heating Furnace, double-ended, gas fitted, heating chamber 36in. wide by 24in. deep by 9in. high, total length through furnace 32in. working, temperature range 900 deg. to 1350 deg. C., can be reached in about 1¼ hours after starting from cold.

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E207 G

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Fielding 800-ton Indenting Hydraulic Press, platens 5ft. 4in. by 4ft. 4in. and 5ft. 1½in. by 4ft. 1½in., with pump and motor.

Fielding 500-ton Vertical Downstroke Hydraulic Press, 42in. by 36in. platens, with pumps and motors.

Fielding 200-ton ditto, 3ft. stroke, with pumps and motors (5 available).

Fielding 100-ton ditto, 4ft. to 5ft. stroke, with pumps and motors.

Two 73ft. 4in. by 5ft. Kilns or Dryers, with Crofts Reduction Gear and 27 h.p. motor.

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600

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2500 c.f.m. BELLISS & MORCOM, 100 p.s.i., with 550 h.p. CROMPTON PARKINSON motor, 3·3kV or 400/440/3/50.

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BELLISS & MORCOM Surface Condenser, 8ft. 6in. long by 3ft. 6in. dia., designed for 8400 lb. exhaust steam per hr. maintaining 26in. vacuum when supplied with 29,000 gals. of cooling water per hr. at 75 deg. Fah. Complete with water circulating and condensate pump.

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BELLISS & MORCOM Condenser, 17,000 lb. steam per hr. at 25in. vacuum when supplied with 43,000 gals. of cooling water per hr. at a temperature of 80 deg. Fah. Complete with extraction pump and air ejector.

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MOBILE CRANE.—Unused 2½-ton Diesel by Herbert Morris, Ltd. As new. 25 cwt. lift at 10ft. 9in. maximum outreach. £1610 (half list price.)—DAVIES, 20, Whiteladies Road, Bristol, 8. E2389 G

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E R

By Order of the Minister of Supply

GOVERNMENT SURPLUS STORES

SALES BY AUCTION

		Main Location	*Auctioneers*
May 22	**Miscellaneous stores.**	General Stores Sub Depot, **Longtown, Nr. Carlisle.** (Sale at County Hall, Carlisle.)	**HARRISON & HETHERINGTON, LTD.,** (Dept. L), Botchergate, Carlisle. (Tel.: 26292/3.)
May 26	**Vehicles and miscellaneous stores,** including :—	M.O.S. Storage Depot, **Bowhouse, Hurlford, Nr. Kilmarnock.**	**DIXON & WALLACE, LTD.** (Dept. L), Bank Buildings, Graham Square, Glasgow, E.1. (Tel.: Bridgeton 2447.)
	Saloon cars ; utilities ; trucks ; trailers ; industrial tractors ; fire pumps ; disc harrow ; M.T. spares ; rivetting and drilling machines ; presses ; grinders ; electric sewing machines ; canteen and kitchen equipment ; furniture ; transformers ; rectifiers ; motors ; switches ; lifting gear ; paint ; grease ; water piping ; asbestos sheets ; trolleys ; wood and steel boxes ; cylinders, etc.		
May 29	**Miscellaneous stores.**	Command Ordnance Depot, **Coypool, Marsh Mills, Plymouth.** (Sale at Kinterbury House.)	**WOOLLAND, SON & MANICO** (Dept. L), Kinterbury House, St. Andrews Cross, Plymouth. (Tel.: 65356.)
June 2-5	**Vehicles, lifting and earth moving equipment, motor cycles,** etc.	M.O.S. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
June 3	**Miscellaneous stores.**	Northern Command Ordnance Sub Depot, **Barlow, Nr. Selby, Yorkshire.**	**BARTLE & SON** (Dept. L), 50–52, Merrion Street, Leeds, 2. (Tel.: 2.0898.)
June 10	**Machine tools and miscellaneous stores.**	Technical Stores Depot, **Old Dalby, Leics.** (Sale at Melton Mowbray.)	**SHOULER & SON** (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel. 3081.)
June 16	**Machine tools and miscellaneous stores.**	M.O.S. Storage Depot, **Byley, Nr. Middlewich, Cheshire.** (Sale at New Islington Public Hall, Ancoats, Manchester.)	**J. H. NORRIS & SON** (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)
June 19	**Miscellaneous stores.**	Returned Stores Group, **Reed Hall, Colchester, Essex.**	**FENN, WRIGHT & CO.** (Dept. L), 146, High Street, Colchester, Essex. (Tel.: 3171.)
June 26	**Machine tools and miscellaneous stores.**	Hawker Aircraft Factory, **South Shore, Blackpool.**	**LESLIE A. BUTSON** (Dept. L), 16, Birley Street, Blackpool. (Tel.: 21073.)

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E118 J

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E5486 G

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F113 G

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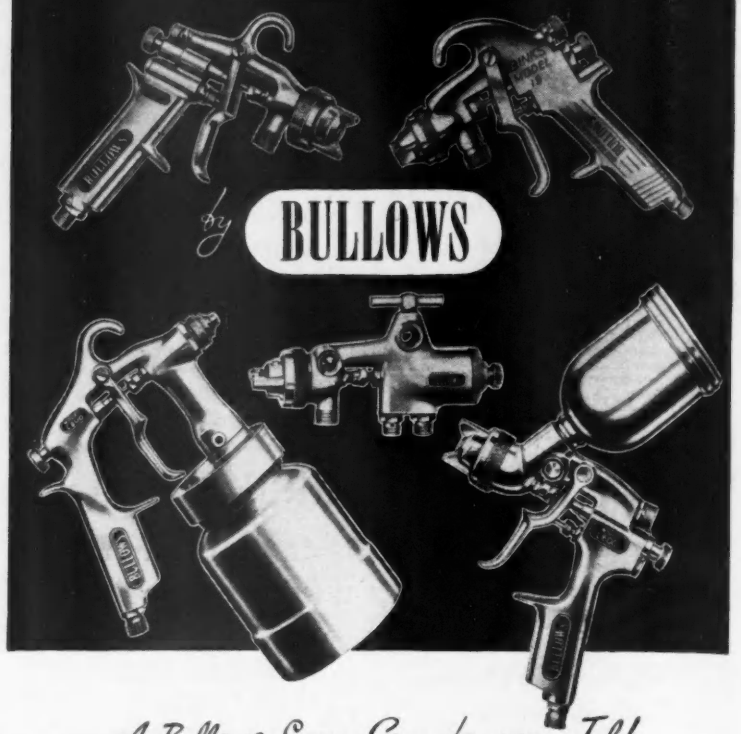

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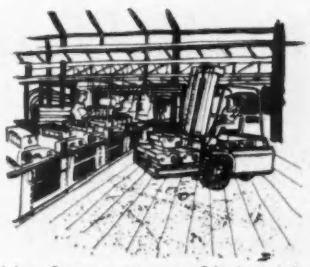

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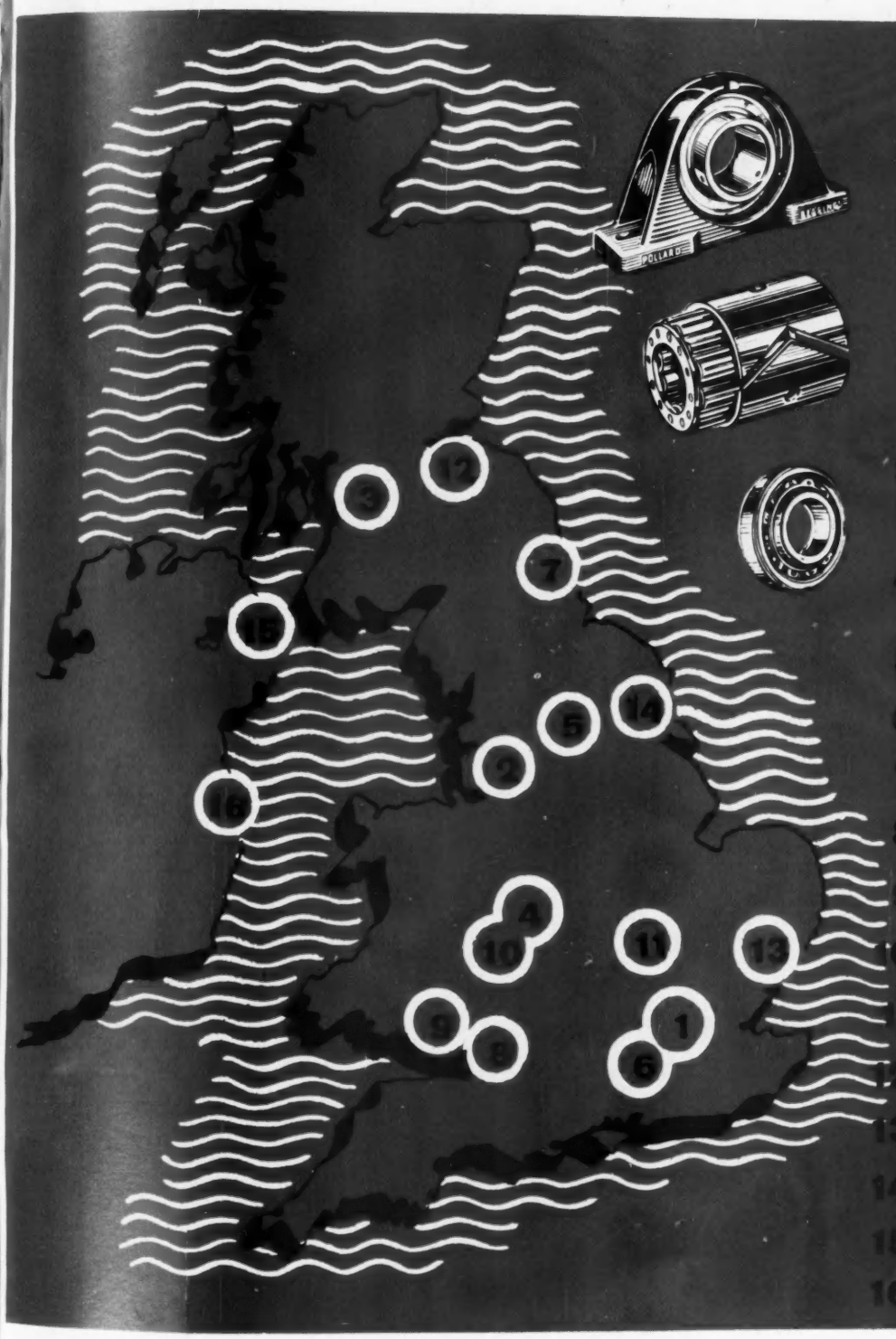

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